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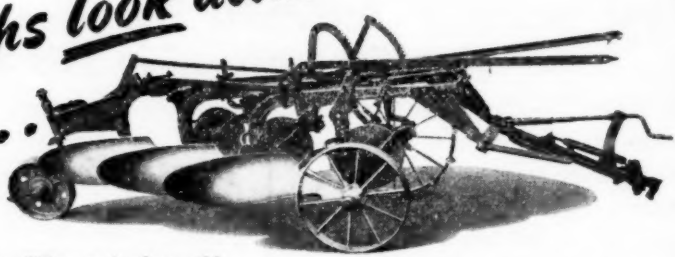

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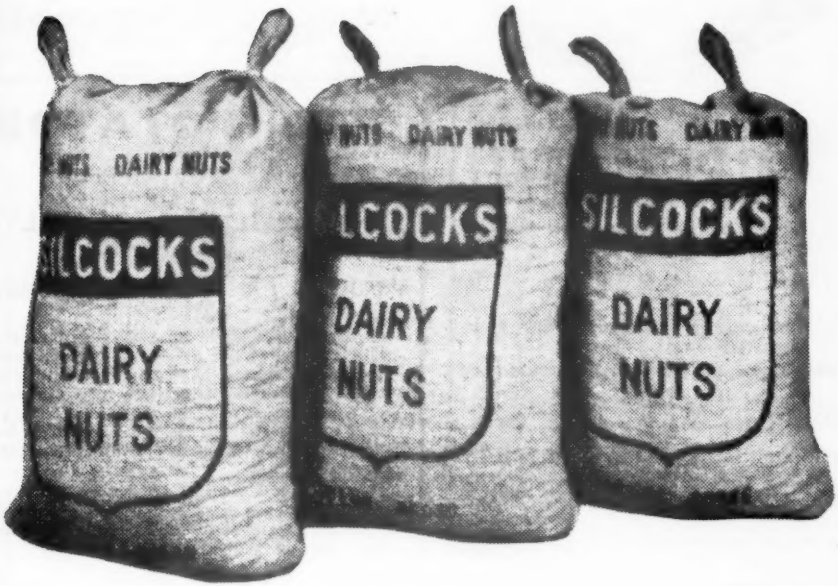

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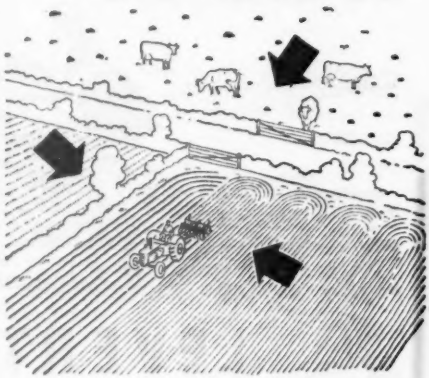

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Editorial Offices: St. Andrew's Place, Regent's Park, N.W.1 (*Phone: WELbeck* 7711)

VOL. LVI No. 11 FEBRUARY 1950

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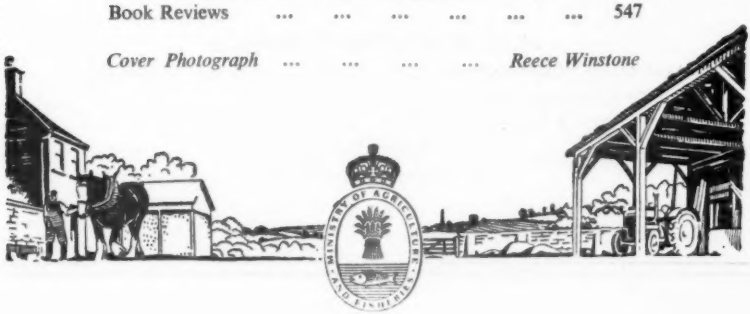

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AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

VOL. LVI No. 11 FEBRUARY 1950

GROWING SPRING WHEAT

D. H. ROBINSON, PH.D.

West Midland Province, National Agricultural Advisory Service

ONE change which has taken place in English farming since 1939 is the growth in popularity of spring wheat. It has always been said in the textbooks that autumn-sown wheat far outyields spring-sown wheat: but experience in some parts of the country with the newer spring varieties suggests that the difference in yield is not so great as it used to be, and that in special conditions spring-sown wheat may be expected to give even better returns than that sown in the autumn.

This, of course, is not a recommendation to switch over from autumn to spring sowing. Winter wheat has a long growing period, and in favourable circumstances may give weights of grain exceeding 40 cwt. per acre—a yield not normally approached by spring varieties. There is, too, the convenience of getting as much sowing as possible done in the autumn so as to relieve the rush of spring work. But nowadays there is no need to give up the idea of growing wheat if for any reason it is impossible to get it sown before the end of February: but, and it is an important "but," the right varieties must be used.

The Right Varieties Many farmers have bought seed of winter wheat in good time for sowing, but have had to postpone drilling for various reasons, until suddenly they find themselves with January far advanced and the seed still in the bag. What are they to do? Can they sow with safety or should they scrap the seed and buy a spring variety? This is a most difficult question for the advisory officer to answer, since so many factors come into play. If the farmer has already bought the seed of such early-ripening winter wheats as Holdfast, Yeoman, Squarehead's Master and Jubilegem, and can drill before the last week of February, he is not taking a wild risk. But, of course, he would be foolish to *buy* seed of any of these varieties in January or February, and equally ill-advised to drill any of the late-maturing varieties like Scandia at this time of year.

Even Little Joss is a poor proposition in March: cases are not uncommon in the West Midlands where Little Joss planted after mid-March has produced scarcely any heads at all, and has behaved more like a fodder grass.

For sowings from the middle of January onwards the true spring wheats are greatly superior; from my own experience in the West Midlands since 1940, I would recommend the following varieties: for very early spring sowing, Bersée and possibly Vilmorin 29: for February-March sowing, Atle: for latest sowings, Fylgia.

Bersée is a popular French variety with a large, coarse, red grain, having a thick coat not too well liked by millers—a point of relative unimportance at the present time. Bersée stands very well and yields handsomely, crops of 30 cwt. per acre being quite common in suitable conditions. It does well on a

wide range of soils, but prefers a well-bodied land. It has this further virtue in the eyes of many farmers—it does equally well in the West Midlands as a winter wheat as a spring wheat, so that a man who buys seed for autumn drilling has no worries about seed if by some mischance he cannot sow before Christmas.

Vilmorin 29 (or Hybrid 29) is another French variety which has given satisfactory crops in the West Midlands when sown early, though it is not so commonly met with now as a few years ago, possibly because of its susceptibility to Loose Smut. It is a red-grained, white-chaffed variety with very good straw, having much the same range as Bersée.

Atle is the most popular spring wheat in the West Midlands—and with good reason. It is a Swedish variety, having very rigid straw and a smallish grain of first-class milling and baking quality. These characters make it an almost ideal plant for the combine harvester, and for fertile soils it can be thoroughly recommended. It is very dangerous to talk about yields per acre, but good growers on good land are disappointed if they harvest under 30 cwt. per acre. Occasionally Atle suffers from "ear-tipping," a complaint characterized by the absence of grain at the top of the ear : there seems some doubt whether this is caused by frost or by dryness of the subsoil.

The variety Fylgia was introduced into this country from Sweden in 1938 by one of the leading seed-houses in the West Midlands, and became widely used from 1941 onwards as more and more grassland was broken up for wheat. The chief reason for this is the capacity of the variety to give a reasonable yield from very late sowings. In fact it is frequently said that for best results Fylgia should not be sown until the end of March, and there are cases where Fylgia has been a success when sown late in May. Another astonishing thing about Fylgia is the range of soils on which it will thrive. The clayland farmer, for example, has been able to get about 20 cwt. per acre from March-April sowings, where formerly April Bearded or Red Marvel could not hope to reach this figure. Yet the lightland crops of Fylgia have also proved quite satisfactory.

On some of the easy-working sandstone soils the varieties Meteor and Extra Kolben II have been used. Neither of these stands as well as Atle, for the straw is appreciably longer. Meteor is on the recommended list of the National Institute of Agricultural Botany, but my own view is that unless Meteor and Extra Kolben II are known to fit in specially well with the farming of a particular farm, then it is preferable to select spring varieties from the Bersée—Atle—Fylgia list. If spring wheat *must* be sown late on poor land where birds are a nuisance, a case might be made out for April Bearded, but this variety is really very poor and is best forgotten by most farmers.

Good Cultivation and Manuring Cultivations for spring wheat are worth doing well because the growing season is short. Winter wheat can be put into a roughish seedbed because the plants have plenty of time to establish their root systems before turning their energy towards straw and ear production. But with spring wheat growth must be continuous, so that soil conditions must be made as ideal as possible. The later the sowing the better should be the seedbed : for the later spring wheat sowings, cultivations should be done as thoroughly as those for spring barley.

The best barley growers sow their seed quite shallow, and it would be interesting to have some precise information about the best depth of sowing for spring wheat. One would expect spring wheat to appreciate much shallower sowings than winter wheat, but experimental evidence on this point is lacking.

GROWING SPRING WHEAT

Spring wheat does not tiller so much as winter wheat, consequently more seed must be sown per acre. The seeding rates usually recommended are from 1½ to 1¾ cwt. per acre (say, 170–200 lb. or about 3 bushels). These rates are probably too high and could well be reduced on fertile soils by at least ¼ cwt. per acre.

Years ago the farmer usually reckoned to grow his wheat upon the manurial residues of a preceding crop, for the price of grain was low and it did not pay to manure at all heavily. Now the situation is very different, and with wheat at 27s.–28s. per cwt. it is profitable to plan for a heavy crop, especially since the combine harvester has reduced harvesting costs. In the West Midlands we have no chalk soils on which added potash is essential for success, but there are large tracts of land on which the phosphate position must be watched. It is wasteful to be too liberal with either potash or phosphate for spring wheat, and rarely can it be profitable to use more than 1 cwt. muriate of potash and 2–3 cwt. superphosphate per acre (or their equivalents in compound fertilizer) even if spring wheat follows a straw crop.

West Midland Field Trials. But we of the N.A.A.S. feel that the value of nitrogen for spring wheat could be more fully appreciated, and we have figures to support our argument. Most of the experimental evidence about manuring relates to winter wheat, but in 1948 the Field Experiments Committee of the West Midland Province began a series of trials to find out what happens if increasing amounts of nitrogen are applied to the seedbed (not as a top dressing) for spring wheat. The results are interesting, and we hope valuable, and although we have records for only two out of the three seasons over which the trials will extend, it does not seem premature to publish the figures.

All the trials were replicated and conducted in such a way that the results could be examined statistically. The treatments at all centres in both seasons consisted of applications of sulphate of ammonia at 0, 1, 2, 3 cwt. per acre, applied to the seedbed at sowing time.

In 1948 trials were carried out in Worcestershire (two centres), Staffordshire, Warwickshire and Herefordshire; the varieties used were Atle and Fylgia. In Staffordshire, Atle gave no response to added nitrogen, owing, it is thought, to the growth of surface weeds, including couch grass.

In 1949 there were two centres in Herefordshire and one each in Warwickshire and Worcestershire; the varieties were Atle and Bersée. The responses to increasing amounts of sulphate of ammonia are set out in the Table below.

Influence of Nitrogen on Yield of Spring Wheat

Sulphate of Ammonia *cwt. per acre*	Yield of Wheat (*cwt. per acre*) 1948	1949
0	26.8	22.2*
1	30.1	24.8
2	30.5	26.1
3	32.3	26.7
Standard Error	+0.68	+0.51

* These figures are low because of a very poor crop in Worcestershire. If the Worcestershire figures are excluded, the averages for the other three centres are 25.2, 28.0, 29.2 and 29.7 cwt.

From these figures it appears that the application of 1 cwt. sulphate of ammonia may be expected to give, on a modest estimate, an extra 2 cwt. of grain, and that there is a sporting chance of getting another hundredweight of grain from the next hundredweight sulphate of ammonia. If the cost of buying and applying 1 cwt. sulphate of ammonia be taken at 18s. per acre, and the value of wheat at 28s. per cwt., the return from the first

hundredweight sulphate of ammonia can be put at about £2 per acre. The extended use of moderate dressings of a nitrogenous fertilizer can, therefore, be recommended as a business proposition, not only for the farmer himself but also for the nation. In the West Midlands our recommendation would be 1 cwt. per acre sulphate of ammonia or 3-4 cwt. per acre of a compound containing 6 per cent nitrogen and 12 per cent P_2O_5.

It must be made quite clear that even in the wettish season of 1948 there was no lodging on the experimental plots, even at the highest rate of application of sulphate of ammonia. In 1948 trials were conducted in N.W. Herefordshire on a field in very good condition after sugar beet: without added nitrogen the yield of Atle was 32 cwt. per acre: with 3 cwt. added sulphate of ammonia the yield increased to 39 cwt. per acre, but there was no lodging. At the other end of the scale, in 1949 on Lias clay in Worcestershire Atle yielded only 13.1 cwt. without nitrogen: with 1 cwt. sulphate of ammonia the yield increased to 15.4 cwt., and with 3 cwt. of fertilizer the yield reached 17.5 cwt. It seems, therefore, that under both good and poor conditions, spring-sown wheat responds well to nitrogenous fertilizers.

VARIETIES OF CEREALS FOR SPRING SOWING

F. R. Horne, M.A., N.D.A., N.D.D.

Director, National Institute of Agricultural Botany

TO obtain high and consistent yields of grain, the variety must be well suited to the general system of management and to the soil and climate under which it is to be grown.

Varieties for sowing in the spring differ from one another in such characters as their capacity to yield, the date at which they can safely be sown, the quality of the grain, and resistance of the straw to lodging.

Only on the basis of actual yield trials can one variety be accurately compared with another. It is misleading to quote yields obtained from single fields of a new variety and impossible to judge the yielding capacity of a variety simply by its appearance. Many have purchased at a high price a new variety which looks attractive and promising, only to find after two or three seasons that the yield results prove it to be 10 per cent below some of the established and well-proved varieties.

There is a wide choice of varieties to the farmer who can be sure of sowing at an early date in February and whose land is moderately fertile and able to provide the crop with the necessary nitrogenous compounds in such regular quantities that they do not cause excessive growth. During the past 10 years, however, the increased use of nitrogenous fertilizer and greater reliance on mechanized methods of harvesting makes it necessary to favour, on all the better classes of land, varieties with stiff straw, even though their yielding capacity may be somewhat below that of a taller type.

Many other features have to be taken into account, such as the ability of the grain to withstand "shattering" and "sprouting," and resistance of the plant to the principal crop diseases.

The Recommended Lists of spring wheat, barley and oats published by the N.I.A.B.* embody the experience gained in actual yield trials coupled with the reports of specialists in the use of the produce.

* See Farmers Leaflet No. 2 (revised January, 1950) obtainable from the N.I.A.B., Huntingdon Road, Cambridge.

VARIETIES OF CEREALS FOR SPRING SOWING

SPRING WHEAT

Some of the winter varieties such as Yeoman, Holdfast, Little Joss and Squarehead's Master, characterized by their earliness in ripening, can be sown until mid-February. These varieties are, however, liable to fail completely unless sown before cold weather ceases; for, being true autumn varieties, they require some low temperatures during their early growth to stimulate the formation of ears and grain. Without this stimulus the crop remains in a grass-like stage throughout the summer.

Mid-February to end of March sowings

ATLE, a cross between Extra Kolben and Saxo and bred by Weibulls (Sweden), has given the most consistent yields over a wide area. The straw is particularly short and resistant to lodging, making it one of the best varieties for use as a "nurse" crop for herbage seeds. The grain is of excellent milling and baking quality and does not sprout readily at harvest time. Atle benefits greatly from being early sown and does best on fertile soils.

Although Atle was not recommended for use in Sweden, it has proved remarkably successful in Britain. This variety offers the greatest scope for increasing the acreage of spring-sown wheat in all the main arable areas, and though many new varieties have been introduced to trials, there is no indication that Atle is likely to be outclassed in the near future.

BERSÉE is an "alternative" variety bred in France by Blondeau, who crossed Allies with Vilmorin 23. It ripens rather later than Atle and is of poor milling and baking quality; the yield of grain when sown on good soil during February is usually high. The straw carries more leaf than Atle but is fairly resistant to lodging.

METEOR, bred by Gartons from April Bearded × Yeoman, usually gives rather lower yields than Atle or Bersée when sown in February. Being earlier to ripen, it has certain advantages on land of moderate fertility when sown in March. As the straw is longer and less resistant to lodging, Meteor is not suitable for the richer soils.

April sowings

FYLGIA, bred at Svalöf (Sweden) from Aurore × Extra Kolben is one of the earliest maturing varieties and is suitable for quite late sowing. This variety has proved successful in the later harvesting districts though, on account of its longer straw, it is not suitable for very rich soils. The grain is inferior in milling quality to Atle.

ATLE is sometimes grown in April with success on rich fenland soils but is unsuitable, on account of reduction in yield, for late sowing on all soils of average fertility.

APRIL BEARDED is an old British variety of unknown origin; it has weak straw and cannot be recommended, except where a bearded variety is desired.

SPRING BARLEY

Varieties of High Malting Quality

PLUMAGE-ARCHER, is a broad-ear variety which is still unsurpassed for the production of malting barley on fertile soils. The grain is large and plump and is preferred to narrow-ear varieties by maltsters in some areas. The straw is moderately resistant to lodging and is less brittle than the older variety, Plumage.

SPRATT-ARCHER is a narrow-ear variety giving slightly smaller grain than Plumage-Archer; under suitable conditions of sowing and harvesting, the grain is of excellent malting quality. When grown on land of medium

fertility, the straw stands well; on account of the high-tillering capacity of this variety, the seed should not be sown at a high rate.

EARL, a single-plant selection from Spratt-Archer by Dr. Hunter of the Cambridge Plant Breeding Institute, has a yield and quality of grain closely similar to Spratt-Archer and ripens 7 to 10 days earlier.

GOLDEN ARCHER, bred at the Warminster Plant Breeding Station from a cross between Plumage-Archer and Spratt-Archer, closely resembles the latter variety but ripens slightly earlier.

Varieties of Lower Malting Quality

KENIA and MAJA, bred at the Abed Plant Breeding Station (Denmark) from a cross between Binder and Gold, are very similar varieties. Both have short, stiff straw and are suited to more fertile soils than the varieties of highest malting quality. Another feature of special value is the earliness in ripening, enabling the crop to be cut fully ten days before Spratt-Archer and Plumage-Archer, though for malting purposes, Kenia and Maja can scarcely be compared with these varieties.

FREJA, bred at Svalöf from Victory × Opal, is some three days earlier in ripening than Kenia. The straw is shorter than Kenia but is not superior in resistance to lodging. It has shown superiority in all yield trials in northern districts and generally throughout the country in the dry season of 1949; it is accordingly recommended for use in northern areas and where a particularly early ripening variety is desired.

CAMTON is a variety suitable only for feeding purposes. On account of its very stiff straw, it is suitable for producing feeding barley or dredge corn on highly fertile soils. It is late in ripening, corresponding fairly closely with Eagle oats.

SPRING OATS

Spring oats are grown over a greater range of conditions of soil, climate and management than other cereals, and the range of varieties is consequently very wide.

For Highly Fertile Soils

EAGLE, bred at Svalöf from a cross between Victory and von Lockow's Yellow oat, is a high-yielding variety with stiff straw. The grain is rather small but has a thinner husk than Victory. Eagle is the most resistant to frit fly attack of all commonly-grown varieties.

SUN II was bred at Svalöf from a cross between Star and Eagle. Its yielding capacity at a wide range of trials was much superior to that of Victory and superior to Eagle, which it resembles in having a rather small grain. The straw is slightly shorter than in Eagle. Sun II is provisionally included on the Recommended List (see page 504).

MILFORD was bred under the number S.225 at the Welsh Plant Breeding Station from a cross between Victory and the winter variety S.172. This variety has a remarkably short, stiff straw. Although its yield is not superior to Eagle except under conditions where lodging occurs, Milford can be recommended for all soils in a high state of fertility and is particularly suitable where herbage seeds have to be undersown. The grain is small with a thin husk.

ABERYSTWYTH S.84, is a late-maturing variety with good straw, intermediate in strength between Milford and Eagle. Its yield is usually below these varieties.

For Soils of Medium Fertility

ONWARD, bred by Gartons from a cross between Marvellous and Superb, matures very early and gives good yields. The grain is very short and plump, making an attractive sample, although the husk percentage is high.

STAR is a cross between Victory and Crown selected at Svalöf and gives consistent yields of grain with a thinner husk than Victory. This variety could with advantage replace Victory on many soils of average fertility where it is now grown.

MARVELLOUS has stout, stiff straw but its use is limited to fields to be sown not later than February. The grain and straw are coarse.

EARLY MILLER was bred from Potato × Record by the Scottish Society for Research in Plant Breeding, Corstorphine. It is rather earlier and has a stiffer straw than Victory and is recommended for use in Wales and northern England.

CRAIG'S AFTERLEA (Aa.708), bred by the Scottish Society at Corstorphine, is some six days earlier than Victory; the average yield is rather below Victory. The length of straw is considerably less than Victory and has greater resistance to lodging. Craig's Afterlea is provisionally recommended for use in northern areas.

SUPREME, a cross between Bountiful and Abundance bred by Gartons, is a black oat with a short, stiff straw. Where black oats are preferred it is recommended on account of its earliness and fairly stiff straw.

For Soils of Medium to Low Fertility VICTORY, one of the oldest varieties selected at Svalöf, is recommended as the best all-round variety for soils of average to low fertility.

MALDWYN (S.221), a hybrid of Victory and Radnorshire Sprig bred at the Welsh Plant Breeding Station, is higher in yielding capacity than Victory though it has slightly more husk. S.221 ripens rather earlier than Victory and has a very high tillering capacity. It is provisionally included in the Recommended List (see page 504).

GOLDEN RAIN is a yellow oat similar to Victory in yielding capacity and strength of straw. It ripens earlier than Victory and the grain has a rather thinner husk.

For Soils of very Low Fertility BLACK TARTARIAN is an old variety characterized by its long straw, one-sided head and by a thick black husk to the grain. It is late maturing and can only be recommended for special conditions of low fertility.

GENERAL

The best results are obtained from spring-sown cereals when cultivations and manuring are well done and the seed is sown as early as possible. Considerable increases in production can be obtained when fields, formerly of low fertility, are improved through the system of farming so that they can grow with success the varieties associated with better soils.

Approved Stocks Apart from the selection of suitable varieties, it is necessary to use reliable stocks of seed if good results are to be obtained. Cereal varieties cannot usually be identified from their grain, nor is it possible to discover by a study of small samples whether the seed is infected with Loose Smut or contains small quantities of noxious weeds such as wild onions and wild oats. For these reasons it is highly advisable that cereal seed should be taken from crops which have been examined and approved by an experienced person.

The "Field Approved" stocks can be recommended because they are produced under the supervision of the Seed Production Committee and are derived from fields which satisfy certain standards of purity and freedom from disease.

VARIETIES OF OATS FOR SOWING IN THE SPRING

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UNLIKE wheat and barley, oats can be grown successfully on soils differing widely in depth, texture, fertility and lime content, and at altitudes ranging from sea level to upwards of 1,200 feet. It is, however, important to realize that this wide range of adaptability is not a feature of each and every variety of oats but is due to the great diversity of varietal types within the species as a whole. This wealth of varietal forms is largely confined to varieties adapted for sowing in the spring. While both the grain and straw of oats are highly valued as food for cattle, varieties which possess a high ratio of grain to straw are generally the most desirable, because of the higher feeding quality of the grain and its greater value for most classes of livestock.

For Poor Soils The older, unimproved types such as Scotch Potato, Black Tartarian, *Ceirch-du-bach* and *Avena strigosa* have a high proportion of straw to grain, and the grain itself is small. When sown on rich soils they tend to produce an overabundance of straw, which may become severely lodged long before the crop is ripe. These varieties continue to be cultivated on the more acid, often poorly drained, soils of low fertility in the western and northern parts of Britain, largely because they can produce a fairly dependable supply of winter fodder under soil conditions where most of the newer, larger-grained varieties would usually fail. They can also be sown later in the spring than the heavy-grained varieties with less loss in total yield of produce. Where the rainfall is high preference is usually given to Scotch Potato and to *Avena strigosa* when the soil is extremely poor. Black Tartarian and *Ceirch-du-bach* succeed best where the rainfall is not too high. By timely sowing and attention to balanced manuring, these older varieties could quite often be replaced on all but the poorly drained soils by S.220, a black-grained variety, which ripens slightly earlier than Black Tartarian and gives a better yield of grain.

For Rich Soils Passing to the opposite extreme, namely, the very rich arable soils and fields of high fertility that have been down to grass for many years, we are in most seasons confronted with two main hazards, excessive straw growth and severe lodging. Apart from the costliness of harvesting lodged crops, early lodging reduces the yield and quality of the grain and the feeding value of the straw. Of the two, the rich arable soil is perhaps the easier to contend with, since its high fertility is generally due to a good balance of soil nutrients. The old pasture, on the other hand, is rich in organic matter, difficult to consolidate and the nitrogen/phosphate ratio, which is generally too wide for the production of good grain, favours the development of a preponderance of straw. Any attempt to adjust the nitrogen/phosphate balance by the addition of soluble phosphate may aggravate rather than reduce the tendency to lodge. Furthermore, some of these old swards are infected by root-rot fungi which attack the newly sown oats and weaken its power to resist lodging. In practice, the growing of two or more crops of potatoes, cabbage or kale which can efficiently utilize the excess nitrogen is, where feasible, a possible method of bringing such land into a better balanced condition for satisfactory crops of grain. Where oats have to be taken as a first crop, a winter variety such as S.172 sown in the autumn would be less likely to produce an excess of straw than crops raised from sowings made in the spring. Excessive leafiness in autumn-sown crops

may at least partially be controlled by grazing or cutting for silage in early spring. These high fertility soils are, however, potentially capable of grain yields well above two tons per acre, and what is needed is a variety that can convert this potential capacity into the maximum amount of grain.

Plant breeders have attempted to solve the problem by the breeding and selection of varieties with a reduced capacity for straw production and a high ratio of grain to straw. A first variety of this kind bred for sowing in the spring is Milford (S.225) which has short, stiff straw and white grain of medium size and excellent quality. No claim is made that this variety is immune from lodging since there are always some fields, in most seasons, where, through the simultaneous occurrence and interplay of several factors, a lodged or partly lodged crop is almost inevitable. The variety Milford (S.225) has the capacity to produce and carry very high yields of grain on fertile soils with less risk of lodging than any other spring-sown variety, particularly when sown early. Varieties with stiff straw when broken by strong winds have, however, little or no recovery power, and it is also well to bear in mind that loose, loamy soils provide poor root anchorage for storm-swept crops.

For Medium Soils We may next consider the choice and characteristics of varieties for that larger area of land lying in between the two extremes already discussed ; areas where the grain yield expectation ranges from about 14 cwt. to 30 cwt. or slightly more per acre. There is here a wide choice of good grain-producing varieties, some of which are adapted to the lower and others to the higher fertility levels within this range. Most of the bred varieties and single plant selections produced in this country within the last fifty years, or introduced from European countries, come within this group. The popularity of many of these varieties was short-lived ; others remained in cultivation for many years and until superseded by newer introductions.

Abundance, marketed in 1898, an early oat with good quality grain but rather weak straw, may be mentioned as one of the highly successful varieties that remained in cultivation for many years but has now been largely superseded by the Swedish variety Victory. This variety is at the present time one of the most widely grown in Britain on soils of average fertility. It is a reliable cropper with grain of good quality and ripening rather late. Under improved standards of farming, and the increased use of fertilizers and fertility-building temporary leys, Victory has insufficient strength of straw to withstand lodging. When the yield expectation is over 20 cwt. per acre, it is usually advisable to select a stiffer-strawed variety such as S.84 or Eagle. The former is rather more resistant to lodging than Eagle and is better adapted to the higher rainfall conditions of the western and south-western parts of the country. Eagle, on the other hand, with its small grain and thinner husk gives the higher yield when grown under the drier conditions prevailing in the eastern parts of England. Both varieties, like Victory, are rather late in reaching maturity. Golden Rain II, a medium ripening oat with yellow grain of good quality, has straw slightly stronger than Victory but weaker than that of S.84 and Eagle. It is, however, a good general-purpose feeding oat and does well on soils of a peaty nature. Earlier ripening varieties with straw intermediate in strength between Victory and S.84, are Star, Onward, and Supreme.

For soils of average and above-average fertility, the best of these is Star, which is an excellent high-yielding, general-purpose variety, producing white grain of good size and quality. Onward, while capable of giving high yields of grain, has a tendency for the stem to break below the ear when stormy weather occurs near harvesting time. The grain, though large, bears a thick

husk which lowers its feeding quality. Supreme, an oat with black, plump grain and a low proportion of kernel, is one of the earliest varieties to ripen. In grain yield, it is on the average slightly inferior to the varieties already mentioned and, while not producing a big yield of straw, the crop is not very resistant to lodging. An early variety with white grain of good quality and strong leafy straw is early Miller ; it crops well in districts of high rainfall, but the grain yield is often below that of Victory.

More recently introduced varieties are, S.220, already referred to above, which yields well on soils of average and below average fertility ; Maldwyn (S.221) a new early variety with white, medium to medium-small grain, superior in yield to Victory, fairly short straw free from coarseness, of good feeding quality and resistant to lodging ; and Sun II, an oat with white grain of good size and quality with medium length straw that stands well. These two varieties can be recommended for soils of average and above-average fertility and for late districts where early ripening oats are required.

Good Cultivation is All-Important To secure the highest possible yields of grain, it is necessary that special attention should be paid to cultural details. Very deep ploughing on loose, loamy soils is not conducive to the preparation of a firm seedbed, and surface cultivations often fail to provide adequate consolidation at the base of the furrow, where it is most needed. Care should be taken to ensure that the seed used for sowing has been efficently treated with a reliable brand of an organo-mercuric dust to control seed-borne fungi. A well-graded sample of seed should be chosen, and both too high and too low a seeding rate are to be avoided. Sowing should take place as early in spring as a suitable dry and firm seedbed can be prepared. There is a close association between earliness of sowing and high yield of grain, and early sown crops usually withstand lodging better than crops sown late. The critical phase in plant growth is when the plants are young, and husbandry methods should aim at encouraging the development of sturdy seedlings. A small amount of a complete fertilizer applied with a combined grain and fertilizer drill will help to give the plants of an early-sown crop a good start. Early sowing when the soil temperature is still low keeps the plants hardy, leads to earlier heading and the formation of grain at the most favourable summer period. Crops that are slow in starting and late-sown fields tend in general to produce straw at the expense of grain. A firm, well-drained soil, free of weeds that hinder seedling growth, is a fundamental prerequisite to the production of good grain crops.

CLOSE CEREAL CROPPING

EFFECT OF CULTURAL TREATMENTS OF WHEAT ON EYESPOT, LODGING, TAKE-ALL AND WEEDS

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THE great increase in wheat production in this country since 1939 is chiefly the result of expanded acreage. There has also been a small but steady rise in yield per acre, caused mainly by better selection of varieties and improved husbandry. Yields still average less than a ton an acre and can certainly be increased substantially. Important causes of low yield are the inadequate use of fertilizers, especially nitrogenous ones, and the troubles which result from growing cereals at short intervals on the same land.

Successive Cropping to meet Grain Need

Close cereal cropping in places is inevitable if the grain we need is to be produced in this country. In some of the eastern counties 40 per cent (in some years as much as 46 per cent) of the total arable land is devoted to wheat or barley. As these crops are unevenly distributed, they must often be taken in alternate, sometimes in successive, years on the same land. This involves risk of loss from various causes which can to some extent be estimated and prevented.

When wheat or barley are grown in succession on the same land, Eyespot, lodging, Take-all and weeds are likely to cause trouble. Occasionally they all occur together, but Take-all tends to be much the most important on light land, and Eyespot and lodging on medium to heavy land. One year free from the susceptible crops wheat and barley and their self-sown progeny (and oats in Wales and the north) is usually enough to avoid severe attacks by Take-all, provided there are no perennial grass weeds which carry the fungus on their roots. This also allows time to free the land from weeds. But in 1948, when the preceding mild winter was unusually favourable to survival of the Take-all fungus, and the wet spring to its development, Take-all was severe in many crops which did not follow immediately after other cereals. In most seasons rotations like the four-course, in which wheat or barley alternate with other crops, are satisfactory on light land, but on the heavier, better land, except in very dry years, there is considerable risk of loss from Eyespot. Glynne and Moore (1949)* found that about half the winter wheat crops, grown in this type of rotation, surveyed on the heavier land of Britain had more than 50 per cent, and a third had more than 70 per cent, straws infected by Eyespot, causing losses of grain estimated as averaging 15 per cent and 30 per cent respectively. Where fertility is low and the crop is not lodged Eyespot is easily overlooked, although straws are straggled and yield reduced. The risk of loss is increased still more by growing wheat or barley in succession and by factors which help to keep the base of the plant damp, some, like spring rain and heavy soil, being unavoidable, while others, like poor drainage and a dense plant, can be prevented.

Recent experiments indicate some of the methods which can be used to reduce loss from troubles associated with close cereal cropping. They include one at Rothamsted on the fourth, fifth and sixth successive winter wheat crops following a crop which was heavily infected and severely lodged by Eyespot. Similar treatments applied to the same plots each year gave a cumulative effect; they included varying rates of seed sown and of spring dressings of ammonium sulphate; three of the six blocks of nine plots were sprayed with sulphuric acid (12½% B.O.V. by vol. 100 gal. per acre) in autumn and again in early spring. In 1946 Eyespot and lodging were severe; in 1947 weeds were common; and in 1948 Eyespot, lodging, weeds and Take-all were very prevalent on control plots.

Spraying with Sulphuric Acid

The striking effect of spraying in reducing lodging is shown on page ii of the art inset and in Table 1. Spraying had no effect on straw yield, except in 1948, when it increased it by an average of 17.6 cwt. per acre, at the same time reducing lodging from 58 per cent to 3 per cent, by decreasing the severity of Eyespot infection.

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* GLYNNE, MARY D. and MOORE, F. JOAN, *Ann. appl. Biol.*, 1949, **36**, 341-51.

Table 1. Effect of Spraying with Sulphuric Acid

	Harvest Year					
	1946		1947		1948	
	Control	Sprayed	Control	Sprayed	Control	Sprayed
Percentage of straws severely infected by Eyespot	70	37	8	4	52	13
Percentage of area lodged	90	31	0	0	58	3
Percentage of area covered by weeds..	—	—	76	34	76	14

The spectacular effect of spraying on weeds is shown on p. iii of the art inset. Unfortunately the spraying had no effect on Take-all.

Previous experiments had shown that the most effective date for a single spraying is in early spring, before the disease has penetrated more than about two leaf sheaths. The outer infected leaves are burnt off, leaving a healthy central part to produce ear-bearing straws. The precise date depends on the state of the crop ; at Rothamsted, for crops sown in October, it is generally advisable to spray before mid-March. When spraying is delayed a month, as it commonly is when applied for weed control, it is often too late to control Eyespot ; the earlier spraying, which controls both Eyespot and weeds, therefore pays better.

Spring spraying damages the plant ; it seems likely that reduced infection only compensates for this damage when adequate nutrients are available, as on plots which receive nitrogenous fertilizers.

Autumn spraying is done after sowing and before plants emerge ; it destroys the fungus on bits of stubble on the surface of the soil. It is generally much less effective than spring spraying, but a maximum effect is obtained when both treatments are applied. It remains to be determined under what conditions the effects of autumn spraying are great enough to be economic.

Spring Dressings of Ammonium Sulphate

Ammonium sulphate, applied soon after spring spraying, increased the yield of straw and the percentage of straws severely infected with Eyespot, both effects contributing significantly to an increase in the area lodged. The fertilizer produced increments in grain yield only when lodging was slight or absent.

Table 2. Increments in Grain Yield and Area Lodged

Harvest Year	Treatment	Increments in Grain (cwt. per acre) for each dose of 2 cwt. per acre Ammonium Sulphate		Percentage of Area Lodged		
		1st dose	2nd dose	Ammonium Sulphate (*cwt. per acre*) 0	2	4
1946	Control	0	—1.3	88	90	94
	Sprayed	+2.3	—0.5	15	30	50
1947	Control	+2.3	+2.5	0	0	0
	Sprayed	+4 6	+1.1	0	0	0
1948	Control	—0.3	+1.0	15	69	89
	Sprayed	+7.1	+2.1	0	1	4

Lodging can best be reduced, not by lowering soil fertility by witholding fertilizers and so reducing yields, but by adopting other means for controlling Eyespot and lodging and so enabling the crop to make the utmost use of the nutrients available.

The best date for applying nitrogenous fertilizers to crops affected with Eyespot is the subject of experiments now in progress.

The use of short-strawed varieties, which lodge only when very heavily infected, reduces, though it does not eliminate, the effect of Eyespot. Many of these varieties do not yield as well as the long-strawed kinds when grown under poor conditions, so that it is especially important to feed them well, particularly with nitrogenous fertilizers.

Seeding-Rate Another means of reducing Eyespot, lodging and Take-all is to lower the seeding rate. Each plant then has more food and produces extra tillers which protect the central ear-bearing shoots from infection by Eyespot, and improved ventilation facilities drying around the plant bases also reducing Eyespot ; the plants produce new roots which compensate for those attacked by Take-all. In this experiment 1 bushel of seed had about the same effect on lodging in 1946 as did 2 cwt. ammonium sulphate ; the effect was obscured in 1948 by the dwarfing effect of Take-all, which was greatest in densely sown plots.

Take-all increased with the seeding rate, and decreased with each dose of ammonium sulphate (Table 3).

Table 3. Effect of Ammonium Sulphate and Seeding Rate on Take-all caused by Ophiobolus graminis

Percentage of area covered by patches of Take-all (July 26, 1948)

Rate of Sowing (*bushels per acre*)	Ammonium Sulphate (*cwt. per acre*)			
	0	2	4	Mean
1½	20*	13	2	12
2½	30	10	5	15
3½	65	18	9	31
Mean	38	14	5	—

* Means of six plots.

The importance of applying the fertilizer early if Take-all is prevalent was shown by the control of Take-all in this experiment in which ammonium sulphate was applied in early March, while severe infection was seen in neighbouring crops where its application had been delayed until April.

In the three successive years minimum grain yields fell from 23.9, 21.5 to 11.7† cwt. per acre. But despite the prevalence on control plots of Eyespot, lodging, Take-all and weeds, yields of more than 29 cwt. per acre were maintained until the sixth successive wheat crop in 1948 by optimum treatments, which included spraying, early application of ammonium sulphate and thin sowing.

† Means of 3 plots.

Table 4. Yield of Grain. Effects of Spraying, Ammonium Sulphate and Varying the Seeding Rate, on the Sixth Successive Wheat Crop

Seeding Rate	Treatment	Yield of Grain (*cwt. per acre*)		
		Ammonium Sulphate (*cwt. per acre*)		
		0	2	4
1½	Control	17.7*	13.6	17.3
	Sprayed	18.9	26.2	29.1
2½	Control	17.0	16.1	17.6
	Sprayed	19.1	23.5	24.3
3½	Control	11.7	16.1	14.7
	Sprayed	15.0	24.7	27.2

* Means of 3 plots.

Experiments of this kind show some of the methods whereby yields can be increased. Many more are needed in different regions and seasons on various types of soil to determine which methods can be used most effectively under different conditions. The use of sulphuric acid has given very encouraging results on fertile and on well-manured soils when Eyespot was prevalent. Before it can be recommended for general use experiments are needed to determine the conditions under which spraying with sulphuric acid is economic.

The 1950 Harvest Emphasis should be placed on the importance of early spring application of nitrogenous fertilizers on light land, especially where previous cropping suggests that Take-all is likely to occur.

There is still time to make up for deficiencies in acreage by growing spring-sown varieties. Although wheat generally yields less when sown in spring than in autumn, there are points in favour of spring sowing. The crop is much less likely to suffer from Eyespot or Take-all, and there is time to free the land from weeds, especially wild oats, which are not controlled by spraying.

THE CONTROL OF TAKE-ALL UNDER INTENSIVE CEREAL CULTIVATION

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TAKE-ALL, caused by the fungus *Ophiobolus graminis* Sacc., is typically a disease of intensive cereal cultivation. In recent times the first "flare-up" of this disease occurred during the temporary popularity of intensive "mechanized" cereal growing under the economic difficulties of the early nineteen-thirties; the second was due to another intensification of cereal cultivation made necessary by the 1939–45 war. Owing to present economic difficulties, it is not yet possible to make a general return to those well-tested crop rotations that have been known for at least half a century to keep down Take-all to a safe, even negligible, level. Fortunately, new methods for controlling this disease are now available, as a result of intensive research work carried out at the Rothamsted Experimental Station* and abroad, during the last fifteen years. These methods, and the principles underlying them, are described in this article.

* See Rothamsted Annual Report for 1946, 60-64.

The Importance of Maintaining Soil Fertility

The results of a field experiment carried out at the Woburn Experimental Station during 1943–46* showed very clearly that *the adequate use of artificial fertilizers will do more to prevent loss from Take-all than any other single control measure.* Application at a rate sufficient to eliminate loss from Take-all completely would not be economic, but a substantial increase in the current rates of nitrogen application for spring-sown wheat and barley, and for the early spring top dressing of winter wheat, will more than repay the outlay, by reducing losses from Take-all. It is especially important to give the second white straw crop (which should be spring sown on light land—see next section) a heavier dose of nitrogen than is usually applied at present, for the second crop is drilled on land already impoverished by the first one. For the same reason the second crop should also receive phosphate, and potash as well on soils deficient in this nutrient.

The reasons for this beneficial effect of high soil fertility in reducing loss from Take-all are simple. A well-nourished plant has an astonishing power of recuperation in its ability to put out a succession of new roots to replace those damaged or destroyed by the Take-all fungus. And secondly, a damaged root system can absorb the essential plant nutrients more easily from a soil in which the concentration of these nutrients is kept at an adequate level by the well-planned use of fertilizers.

On light land the second white straw crop should always be spring sown. *The interval between harvest and autumn drilling is insufficient to reduce the amount of Take-all fungus surviving in infected roots and stubble to a safe level.* Research has repeatedly shown that enough of the fungus may be present on the roots of an apparently healthy wheat crop (i.e., one showing no whiteheads) to ruin a second autumn-sown crop immediately following. The improved varieties of spring wheat such as Atle now available should make this requirement not an undue hardship for farmers who wish to take a second crop of wheat.

The Chamberlain System

Research work at Rothamsted was especially directed towards finding out how the dying-out of the Take-all fungus could be hastened in the interval between harvest and spring sowing. It was found that the fungus could be most quickly starved out by arranging for a temporary shortage of nitrogen in the stubble soil. This requirement at first sight appeared difficult to fulfil under ordinary farming practice, until in 1943 Mr. W. Buddin, Advisory Mycologist for the South-East Province, drew attention to the possibilities of the Chamberlain system for intensive cultivation of spring-sown cereals†. Mr. F. P. Chamberlain, of Crowmarsh Battle Farm, Benson, Oxfordshire, had devised a system of sowing barley simultaneously with a seeds mixture made up of 10 lb. trefoil (*Medicago lupulina*) and 10 lb. Italian ryegrass per acre. The seeds mixture usually makes a good growth in autumn after barley harvest, and can be ploughed in about the turn of the year in preparation for the next barley crop. Under this system Mr. Chamberlain has grown consecutive barley crops for more than a dozen years on the same land, with no deterioration either in yield or health of the crops.

This system was devised by Mr. Chamberlain primarily for the maintenance of soil organic matter and fertility without the use of stock. It is important to note that *this system also fulfils two important requirements for*

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* See *Ann. appl. Biol.*, 1948, **35**, 435-42.

† See *Agriculture*, **54**, 425-6.

control of Take-all: (1) *low soil nitrogen in between crops, and* (2) *high soil nitrogen while the crop is growing.* Contrary to a wide belief, the active growth of trefoil on the stubble land takes up all the free nitrogen in the soil. But when the trefoil is ploughed in, its accumulated nitrogen and other nutrients are liberated by decomposition in time to benefit the following barley crop, and to assist it to resist attack by any Take-all fungus that has survived the winter. Mr. Chamberlain's success with this system must also be due in part to his liberal use of fertilizers as a supplement to the green manuring.

The Chamberlain system can be used wherever a second or third spring wheat or barley crop is to be grown, and will thus be a useful adjunct to many crop rotations. In the field experiment at Woburn this system gave the best results of any expedient tested for maintaining soil fertility and preventing loss from Take-all. Mr. Chamberlain's own seeds mixture was replaced by one consisting of 20 lb. per acre of trefoil alone, because ryegrass can carry the Take-all fungus to a certain extent on its roots, though this carry-over is not usually of much importance. In areas where the Clover Stem Rot disease (caused by the fungus *Sclerotinia trifoliorum* Erikss.) is likely to develop on the trefoil (owing to past cropping history), Mr. Chamberlain's trefoil and ryegrass mixture would be preferable to trefoil alone.

Ploughing-in Straw Farmers using a combine harvester often inquire whether the ploughing-in of extra straw along with the stubble will help to control Take-all. This possibility was tested, and it was found that ploughed-in straw did reduce the amount of Take-all fungus surviving the winter, through its action of taking up available soil nitrogen during decomposition. *But this nitrogen deficiency must be corrected when the next crop is sown, otherwise yield will be depressed and loss from Take-all actually increased.* If straw is ploughed in, it is essential to *increase* the amount of nitrogenous fertilizer at sowing, at the rate of 1 cwt. nitrogen per 4 tons straw. The policy of ploughing in straw along with the stubble, if balanced by an adequate addition of a nitrogenous fertilizer to the seedbed, is therefore an alternative to the Chamberlain system, but in our experience the latter is the better proposition.

In intensive cereal growing, it is essential to secure a good start on clean land, i.e., on land that is free from such perennial grass weeds as couch (*Agropyron repens*), the bent grass (*Agrostis* sp.), and the soft grasses (*Holcus mollis* and *H. lanatus*). These grasses are more dangerous carriers of the Take-all fungus than a wheat or barley crop, because they are so difficult to kill, and because they provide the fungus with living roots on which to feed at all seasons of the year.

POWER ON SMALL FARMS

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IN the August, 1949, issue of AGRICULTURE Mr. R. R. W. Folley examines the case for the light tractor and considers that the outlay of £300 on a standard tractor is an "unwarranted expense on less than 75 acres," although he admits that a complete assessment of the position is hampered by various obscure factors. Having recently analysed information obtained on a tour of some fifty farms of less than 50 acres with tractors, I hope to

show that nothing smaller than a medium-powered tractor can give the small farm the true benefits of mechanization.

In considering mechanization, we must get right away from any kind of static outlook which takes for granted that farm output remains more or less constant every year. The farmer who is going to stay in business plans to, and does, increase output. From the individual as well as the national viewpoint, output is more important than acres. Hence it is wrong to consider what acreage justifies the capital outlay of £300 odd for a tractor. It is the *potential output* that must determine the justifiable capital outlay. We must also get clear in our minds that the fundamental object of mechanization is to enable highly paid workers to produce the maximum amount of best quality food at the lowest possible cost without wrongfully exploiting the soil.

That is the true basis for the use of power on the land, although there are many important secondary considerations such as: freeing land from growing horse feed; absence of physical fatigue in the machine; greater depth of cultivation; more effective use of the weather; the reduction of weather risk in harvesting; dual role of draught and belt work; avoidance of physical toil for the operator; compactness in manoeuvring; one-man control of power unit and implement; speed in transport; reduction of feeding attention and elimination of health risk; absence of secondary expenses like fencing and saddlery accounts.

Although these are subsidiary to the main purpose, each different factor weighs in the mind of the farmer according to local conditions. In actual practice very few farmers enter into financial calculations regarding capital outlay and interest when buying a tractor. Most frequently it is found that they buy a tractor so that they can keep abreast of their work with an inadequate labour force, a reason which comes very near to the true objective of mechanization.

This commonsense outlook is also good business. Over the past two years it has been shown that twelve small medium-powered tractors worked at an average cost of 3s. an hour, including depreciation, when employed for an average of 1,446 hours in the two years, or 723 hours a year. An analysis of costs is given on p. 518.

The Tractor versus the Horse Since labour is the biggest single cost on farms today, it must be financially sound to effect a threefold increase in the worker's output by putting him on the seat of a tractor. In the basic job of ploughing it is probably an understatement to say that a tractor does three times as much as a pair of horses in a day, since the worker will be able to spend all except about ten minutes of his eight hours ploughing, instead of from half to two hours feeding and grooming. Thus a worker costing 2s. 6d. an hour produces the equivalent of 7s. 6d. an hour in wages, not to mention the saving of insurance and office work involved in employing three men instead of one. It is merely changing two halfpennies for a penny to give the worker a machine that is barely capable of the same output as two horses, and even so tires the operator sometimes as much as walking behind horses.

The merging of holdings is no more than a palliative economic theory—and of doubtful soundness—to meet the problems of capital in the mechanization of small farms. Money is of use only when productively employed. Output per worker and per acre are vital in our present economy. In both respects the best small farms beat the best large farms by nearly three to one. Moreover, the best British stock come from the small farms, mainly because of the rugged independence which is developed in the families working them.

Merging, or even contract work, if carried to any length, destroys this and results only in bickering and frustration. The normaly shrewd contractor will go to the biggest (and most profitable) piece of work, and the Devil and the weather may take the smallest!

Transport occupies at least 50 per cent of the time of draught-power on any farm. On some large holdings it is recorded as absorbing 70 per cent of the tractor's time. With a medium-powered tractor, a load of 3 tons can be pulled at 10 m.p.h., compared with a horse's 30 cwt., at something under 4 m.p.h., and with the driver usually tiring himself by walking. The 2s. 6d. an hour spent on labour with a tractor becomes worth over 15s. compared with men working horses.

According to figures obtained at The Lord Wandsworth College, it costs £119 a year to keep a pair of horses, as opposed to £108 for a tractor at the hourly cost (3s.) which has been quoted, for about 700 hours a year. But this saving of £11 a year is not all. Scottish figures show that 1.4 tons of oats and 1.9 tons of hay are needed to keep a horse for a year in working condition. This accounts for nearly 3 acres of land, which becomes 5 or more when grazing is included. For a pair of horses (which do not equal a tractor in output), 10 acres are required. It is a poor farm which, when worked properly, does not make a profit of £15 to £20 per acre. The horse farm therefore loses a potential £200 profit before the horses begin to eat. In short, if the small farm cannot pay with a tractor, it certainly will lose considerably with horses—and this refers only to the maintenance of power and takes no account of the points of superiority in mechanical power mentioned earlier.

One of the most interesting things to be learned in visiting small mechanized farms is that the hours of useful employment for the tractor increase yearly through the introduction of new subsidiary branches of production. At the same time, on the majority of small farms, careful driving by the owner means that the tractors continue to do their work satisfactorily long after they have been written off by the customary procedure of depreciation.

Analysis of Running Costs

Hours worked 1,446

	£	*s.*	*d.*
Maintenance material	6	9	4
Lubricants	9	2	0
Bought labour	2	9	2
Own labour	9	19	4
TOTAL ..	27	19	10

	d. per hr.
Cost per hour as above	4.64
Tyres—33⅓ per cent p.a.	1.928
General overhaul—say £20 p.a. ..	4.97
TOTAL ..	11.538

Fuel, at 2s. 1½d. per gallon ..	12.75
First year depreciation (Less tyres) at 22½ per cent p.a.	10.84
TOTAL ..	35.128

MARGINAL LAND

3. SOUTH-WEST ENGLAND

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The earlier articles in this series appeared in the December, 1949 and January, 1950 issues of AGRICULTURE.

TRAVELLING by road from Bridgwater via Taunton to Exford, one passes from—in a remarkably short distance—some of the richest and most fertile of Somerset land to what is obviously a "marginal" area. Few people would disagree that during this journey one does pass through a "marginal" area, but opinions may differ as to the precise points at which the area begins and ends, and indeed, any line of demarcation could only be arbitrary. No attempt will be made in this article to apply a precise definition to the term "marginal land," but if we eliminate those areas which are true hill farming districts, eligible for the full hill sheep subsidy and also eliminate those areas where end products, such as cereals, milk, beef, are normally produced, then we are left with the main areas containing a substantial proportion of marginal land.

In the south-west of England these areas are situated in the counties of Somerset, Devon and Cornwall. Smaller areas also exist in Gloucester, Wiltshire and Dorset.

The land is classed as "marginal" because of its low inherent productive capacity, which is governed by the fundamental natural factors of soil and climate. Other factors such as aspect, altitude and access have a direct bearing on the potential productivity of farms in these marginal areas. They are the traditional stock-rearing districts of the south-west, but economic factors, and particularly war-time necessity, have brought about a considerable increase in milk production on a substantial proportion of the farms.

The acreage of marginal land in the south-west of England is considerable, and reliable estimates have shown that in Devon alone there is at least 400,000 acres, and in the six counties of the south-west not less than 750,000.

The pastures in the lower and better areas are agrostis (bent) dominant, but with increasing altitude, fine-leaved fescues and heather, etc. become prominent.

There are large areas of rush-infested land ; Holsworthy in Devon and parts of Exmoor in Somerset provide outstanding examples where rushes predominate in field after field over thousands of acres.

All the other problems associated with marginal land can be found in the south-west. Bracken is widely distributed. Capital expenditure is needed on roads, drainage, fencing, etc. On Exmoor, for instance, one finds what must have been not so long ago, some of the finest stock fences in the country, but today the beech hedges are overgrown and the stone banks are in disrepair. It is probably impossible to bring these Exmoor "fences" back to their former state, and even to make them stock-proof by modern standards would be a costly process.

The last half century has brought about profound changes in these marginal areas. People and capital have drifted away and stock are considerably reduced in numbers The close proximity of more fertile land has, in many cases, accentuated these processes. The fertile Taunton vale, for instance, is only a few miles from Exmoor.

To improve marginal land and to bring marginal farms back to their optimum level of production, three problems of fundamental importance have to be overcome: lack of man-power, lack of capital, and lack of stock. Any scheme of marginal land improvement must set out to solve these problems.

Cropping The inherent productive capacity of marginal land will be determined by conditions of soil and climate. The natural soil fertility is usually low and the rainfall invariably high. The crops most suited to these conditions are: ley grass, brassicas (e.g., rape and kale), and oats.

On many marginal farms it is established practice to undersow a cereal crop with a Cockle Park type of mixture and to take "seeds" hay in the first and often the second year. The ley remains down for an indefinite period, and grazing is usually intense and continuous during the winter and spring, especially with sheep. This treatment causes a rapid deterioration in the productivity of the sward, which is very marked from the second year onwards. In order to decide on the type of ley and the most appropriate seeds mixture to use, two things should be decided: (1) the duration of the ley, and (2) the purpose for which it is required. These two factors will be governed by the stock policy and stock requirements on each individual farm.

Seasonal Growth and Stock Requirements The stock-rearing farmer must make provision in his system of farming for summer grazing for the whole of his stock and winter grazing for his ewe flock, together with a certain proportion of his cattle, although in the latter case the grazing will be supplemented by hay, silage, straw, etc. The grass acreage will have to provide a substantial proportion of these winter fodders. His aim will be to reduce the winter feeding period as far as possible by extending the grazing season and providing the maximum amount of out-of-season grazing both of grass and such green crops as rape, kales, turnips, etc. The extent to which this can be achieved will naturally be influenced by the local climate. In the extreme south-west of England, for example, the climate is mild enough for the winter gap to be completely closed allowing for all-the-year grazing, while in areas where the climate is more rigorous this is not possible and a considerable amount of indoor and hand feeding is necessitated. In all districts, however, certain measures can be adopted which will considerably reduce the winter gap at both ends of the season.

The period of early May to the end of September is the season when the grass is in active growth and is a period of abundance of herbage in most years on the stock-rearing farm. Even in these high rainfall areas, however, the effects of drought are often severe, especially when spells occur after a late haymaking season, with a consequent loss of aftermath. During this period, of course, the farmer has to perform the task of conserving his summer grass in the form of hay or silage. It is not proposed here to enumerate the merits and demerits of haymaking and ensilage as conservation processes; suffice it to say that on these marginal farms and to achieve a high level of production, efficient conservation and stock-raising are inseparables. To achieve maximum efficiency in grass conservation, it is essential to cut the herbage soon after the grass heads appear, and the optimum time will normally be early in June. Not only does this ensure the maximum yield of fodder nutrients per acre, but also that there is ample and uniform growth of leafy herbage in July and August. The quantity of silage to be made will, of course, depend on the head of cattle, but it provides excellent feed for young

stock, especially in the lean months of February and March. This is especially the case where two-year-old stores are being carried through the winter for disposal at the spring sales.

During October, and with the advent of cold weather, the growth of herbage ceases and pastures become bare, although after growthy seasons fogged aftermath can hold stock for considerable periods. Nevertheless, abundant growth of herbage in the late autumn cannot be depended on, unless it is methodically planned. The best method of providing abundant grass in the autumn is from maiden seeds (a direct-seeded ley in the year of sowing). A maiden seeds ley will grow well into the autumn and remain winter green for considerably longer than permanent grass or older leys. The value of maiden seeds on dairy farms for the provision of high-quality autumn grazing is now well recognized, and this method is eminently suited to the particular needs of the stock-rearing farmer. It is of the utmost importance to provide the maximum amount of high-quality grass keep for cattle at this time of the year, especially where the green crop is required for sheep and fattening off lambs.

Another method of providing out-of-season grazing is to undersow a cereal crop with Italian ryegrass and alsike or broad red clover (or trefoil in lime-rich soils). This will provide stubble grazing and very early spring grazing and will carry the ewe flock at a time when other leys should be rested. The most convenient place in the rotation to sow this mixture is in a cereal crop to be followed by "green crop" such as rape or thousandhead kale. In this way the Italian ryegrass mixture can be grazed throughout April and into May, when the land will be ploughed and planted to the green crop and by which time the grass will be growing well on the rest of the farm.

Rye is another useful crop to provide winter and spring grazing, but for this purpose it must be sown early in September and not later than the third week of that month. It would be most convenient to use this crop in autumn preceding the maiden seeds year, and to graze it once before Christmas and again in March or early April, immediately prior to sowing the grass and clover seeds, after which the stock can be brought back in a fortnight or three weeks' time. Where the soil is on the heavy side, it is advisable to sow the seeds before grazing. Frequently it will be found that delayed harvesting does not allow for the rye to be sown early enough in the autumn and, in these circumstances, it is advisable not to sow it but to establish the maiden seeds (in the following spring) with a bushel of oats or rye or 1 or 2 lb. of rape and graze in one month after sowing.

Transition Period The rate at which derelict land can be brought back to its maximum level of productivity will depend to a large extent on the natural fertility of the soil. Where the inherent soil fertility is high, land can be brought into full production quite quickly. Many instances of this were seen during the war, when fields on lias clay, often covered in thorn, grew several heavy corn crops immediately after clearing.

Where the inherent fertility of the soil is low, however, it is necessary to go through a period of fertility building before the land can be brought to its optimum level of production. It may be necessary to grow several pioneer crops of brassicas, followed by short-term grazing leys leading up to an orderly sequence of cropping. Such a programme of improvement cannot succeed unless it is closely linked to the livestock policy of the individual farm. Spasmodic excursions into the hills with ploughs and implements have from time to time been followed by disastrous results. Rushes in quantity have appeared where no rushes grew before, and this has usually

been caused by by-passing the essential pioneer-cropping period and to understocking immediately after reseeding. Reseeding without relation to the stock policy will not have the desired results.

For marginal land improvement and ultimate rehabilitation to be successful, it must proceed side by side with a livestock expansion programme. The process must necessarily be a gradual one and cannot be achieved overnight. On the one hand, there must be a gradual building up of soil fertility, and on the other, a complementary increase in the number of stock carried—both leading to a balanced system of farming, suited to conditions of soil and climate.

Rotations The choice of rotation will depend on the type of stock kept on the farm; whether milk production or stock-rearing has the greater emphasis; whether the proportion of sheep to cattle is great or small. Provided there is a reasonably definite stock policy on the farm, then a suitable rotation can be evolved to meet the requirements of the stock at different times of the year.

In the early stages of improvement, a pioneer sequence as follows would restore the fertility status of the soil:

1st year	Rape and turnips (grazed off with sheep)
2nd year	Thousandhead kale (grazed with sheep and cattle)
3rd and 4th years ..	Two-year grazing ley.

A suitable seeds mixture would be:

	lb. per acre
H.1. ryegrass	20
S.100 white clover	2
S.123 red clover	3
	25

The stock-carrying capacity of the land will vary, but in the south-west most of the marginal land can be classed as between "two and three-acre land". By this is meant that 2 to 3 acres of land is required to maintain one 10-cwt. cow through the year and to produce the first gallon of milk throughout the lactation. Thus on a hundred-acre holding of "2-acre" land, the sustained stock-carrying capacity could be made up as follows: 5 nurse cows, 20 calves (under one year old), 20 other stock (one year old and under two), 50 ewes, and 75 lambs.

The following rotation would meet the requirements of this number and type of stock, assuming that store cattle are sold at two years old: Green crop—oats—maiden seeds—ley—down for x years.

As the proportion of sheep to cattle increases, so will it be necessary to expand the acreage of green crop and reduce the length of the ley. By such methods many marginal farms in the south-west have reached a high level of production, and what is more important, that level has been maintained.

BLUEFACED LEICESTER SHEEP

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A STRIKING feature of British sheep farming during the present century has been the development of the lowland grass ewe flock. The most successful sheep for this purpose has proved to be a cross between a hill ewe and a longwool ram. For example, the Half-Bred (Cheviot × Border Leicester) is now famed throughout lowland areas as an economic producer of cross-bred lambs for fattening, and similarly the Greyface or Mule (Scotch Blackface or Swaledale × Border Leicester). The importance of the Border Leicester today is due undoubtedly to its usefulness as a crossing sire in the production of breeding ewes for lowland farms. This article deals with a lesser known and more recent type of Border Leicester, namely, the Bluefaced or Hexham Leicester. This type is becoming increasingly important in the North of England, where it is tending to replace the Border Leicester for crossing with blackfaced hill ewes.

History Much controversy is aroused locally when the origin of the Bluefaced Leicester is discussed. Some consider that the blue skin and light fleece, which are characteristic features of the breed, can only have been introduced by cross-breeding, and the introduction of Wensleydale blood is commonly suggested. The appearance of the Bluefaced Leicester gives some support to this suggestion, for in general conformation, it resembles the Border Leicester, whilst the blue skin and fine fleece are similar to those found in the Wensleydale breed. Some breeders agree that the Wensleydale was used experimentally, but maintain that such blood was not introduced generally, because it produced many disadvantages in the resulting progeny. These included bad conformation of the head, and excessive woolliness on the legs, cheeks and forehead. Prominent breeders insist that the breed arose exclusively from Border Leicester stocks by gradual selection of darker-headed and finer-coated sheep.

The origin of the Border Leicester itself can be traced to the late eighteenth century, when sheep of the English Leicester breed were introduced to the Border country from the Midlands. By breeding and selection, a taller animal with more white on the face and legs was developed, and the new type, i.e., Border Leicester, was first recognized as a separate breed in 1869 by the Highland and Agricultural Society.

In the early history of English Leicesters blue-headed sheep are mentioned, and it appears that two distinct types known as "Bluecaps" and "Redlegs" could be distinguished among the Leicester sheep bred by Robert Bakewell and his contemporaries in Leicestershire[1]. The early descriptions of the "Bluecaps" correspond fairly closely with those of the Bluefaced Leicester of the present day. According to Dixon, some of Bakewell's "Bluecap" strains contributed to the development of the Border Leicester, but as breeders in the North were aiming at a white-faced breed, this type never became dominant. For many years breeders in the Border country experienced considerable difficulty in fixing the white face as a true breeding characteristic. There is considerable evidence[2, 3, 4] that blue-headed sheep, no doubt descendants of Bakewell's "Bluecaps," recurred in considerable numbers, and repeated culling of this feature was practised. In pedigree Border Leicester sheep to this day, black spots on the head and ears, although not favoured by breeders, appear in individual animals.

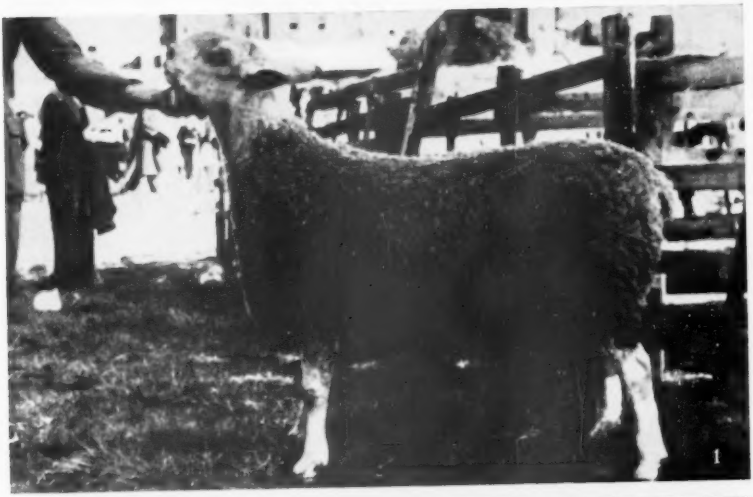
BLUEFACED LEICESTER SHEEP

It was not until the end of the nineteenth century that selection began for a bluefaced and fine-woolled type of Border Leicester. This was first attempted by a small number of breeders in the Hexham area of South Northumberland, where the value of this type of ram for crossing with draft blackfaced hill ewes was beginning to be appreciated. At that time Border Leicester breeders elsewhere were producing whitefaced well-woolled sheep, which were in demand by overseas buyers and were suitable also for mating with the draft Cheviot ewe to produce the Half Bred. When this type of ram was mated with Blackface sheep, however, the resulting Greyface or Mule lambs lacked certain desired qualities. For matings with draft Blackfaced sheep a ram was needed with a light fleece of good quality wool to counteract the heavy coarse fleece of the hill ewe. A skin tinged with blue was also preferred, since it was found to impart an attractive black and white mottling to the face and legs of the cross-bred progeny. Lambs marked in this way were in keen demand in the sale ring, and breeders naturally sought to breed them for this reason. On farms where the better Mule ewe lambs were retained for breeding purposes, the advantage of using a lighter-fleeced and darker-skinned ram was especially appreciated. Thus the Bluefaced Leicester began to emerge.

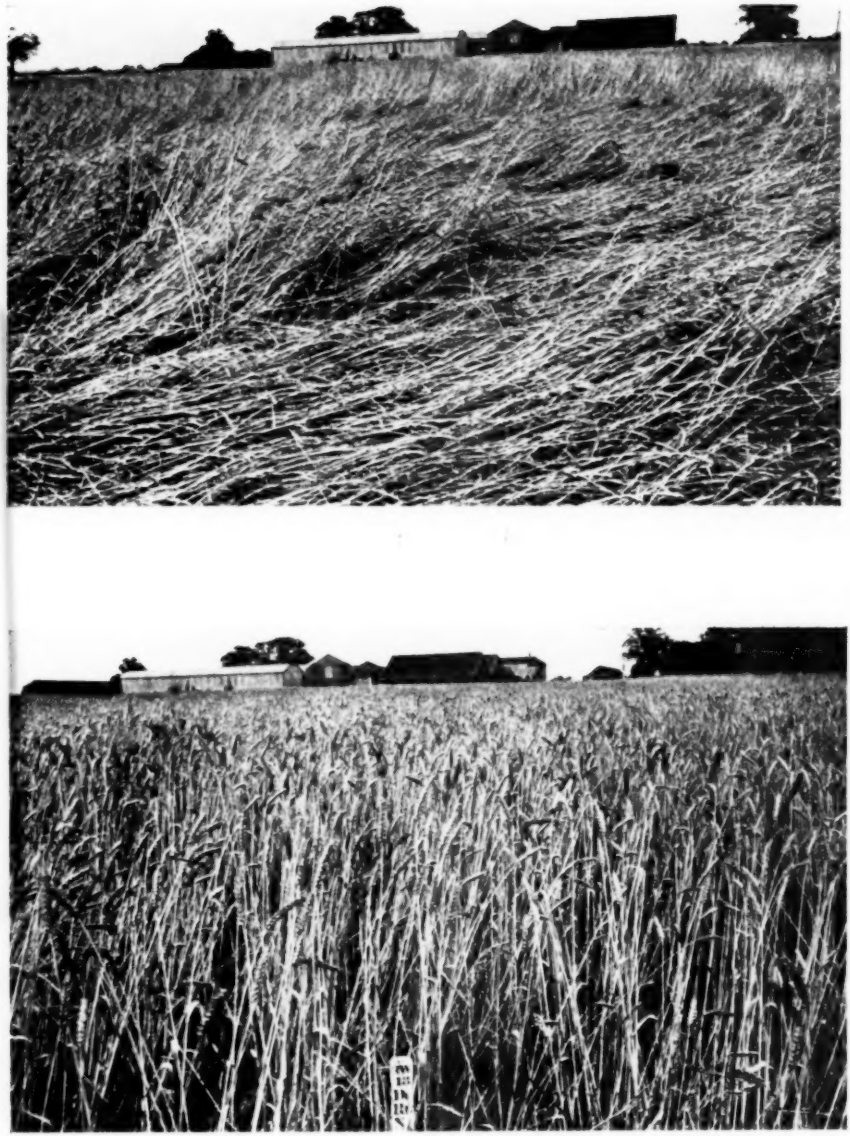
Since the "bluecap" characteristic was difficult to eliminate and traces of it still recur in the Border Leicester, it seems very reasonable to agree with those who claim that the Bluefaced Leicester arose exclusively from the early Border Leicester. Indeed photographs of early Border Leicesters show more resemblance to present-day Bluefaced Leicesters than to present-day pedigree Border Leicesters.

Early breeders, selecting for the Bluefaced type, found it very difficult to breed sheep with size, constitution and good bone and at the same time retain the finer fleece and deep blue colouring which they so much desired. Too often, a sheep which had the correct colouring and a good, fine fleece was inclined to be small and puny, and when size and conformation were good the fleece was rough. Nevertheless by 1914 the bluefaced type of Leicester was becoming well represented at the annual ram sales held at Hexham and other local markets. During the post-war period its popularity further increased when the demand was for an animal with intense blue features and an extremely bare "skin" (fleece). At this time there can be little doubt the breed as a whole was suffering from the effects of close breeding (which was largely unavoidable), as well as from too much emphasis having been placed on the quality of the fleece and colour of the skin. This resulted in some sheep of smaller size, inferior conformation and doubtful constitution. Even so, such animals always had a ready sale, which underlines the importance placed by buyers on colour and fleece type. During the last twenty years breeders have succeeded in producing sheep of better conformation and stronger constitution. This improvement is due to (1) the acceptance of animals with paler coloration and a slightly heavier fleece, and (2) the introduction of new blood in the form of more foundation females from Border Leicester stocks.

Description and Characteristics Bluefaced Leicester breeders do not claim to possess animals outstanding in appearance as individuals. The importance and progress of their sheep are entirely due to the success of their cross-bred progeny (the Greyface or Mule). The ideal crossing ram may be defined simply as one which will produce first-class Mule lambs. As there are considerable differences in type amongst blackfaced ewes, so there must be corresponding differences amongst the crossing rams used. In the Bluefaced Leicester at least two types can now be



1. Bluefaced Leicester three-shear ram.
2. Bluefaced Leicester ewe lamb.
3. Fleece of Bluefaced Leicester ewe lamb. Note "openness" and "pirl".



Effect on Lodging of Spraying with Sulphuric Acid (1948)

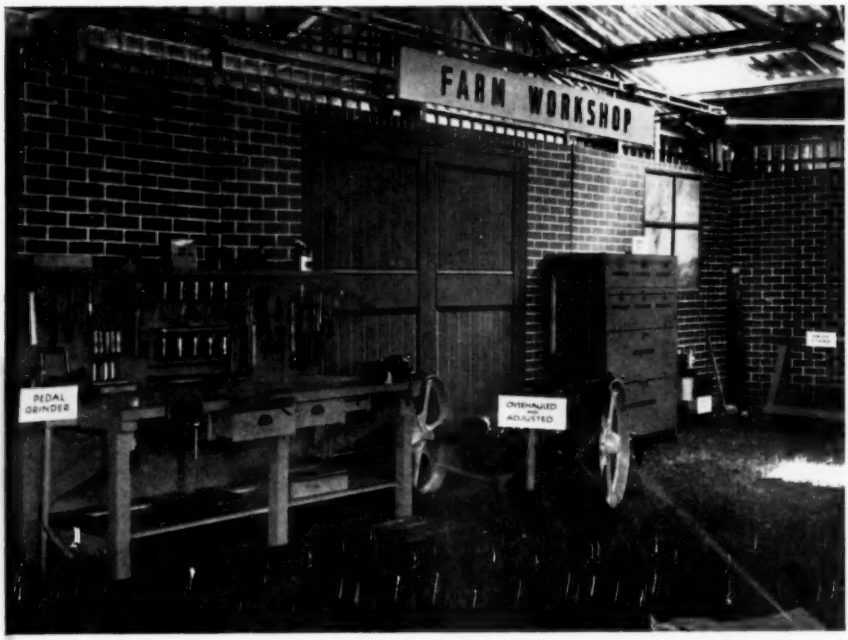
Top: Unsprayed.

Bottom: Sprayed.

Photos, *Rothamsted Experimental Station.*

Effect on Weeds of Spraying with Sulphuric Acid (1947) (showing plots and paths between).

Top: Unsprayed.
Bottom: Sprayed.



General lay-out. A knife and paint store are shown on the extreme right. The cleaning bench (illustrated below) was on the left of the work bench.

Photos. *Sheldons, York.*

Spares Bin and Cleaning Bench.

distinguished: one used for matings with the Scotch Blackface ewe, and a slightly more compact type, with a heavier fleece, stronger bone and shorter leg, which is preferred for matings with the Swaledale ewe.

For ease of description, the Bluefaced Leicester will be compared with its parent breed the Border Leicester, and contrasting features noted. Chief of these are conformation, fleece type, and skin colour. In appearance the Bluefaced Leicester is "rangy" rather than compact. Compared with the Border Leicester, it is longer in the back, higher in the leg, and lighter in the forequarter. The wool is fine in the staple, well pirled, and open to the skin. The fleece is considerably lighter than that from the Border Leicester, 3-4 lb. being an average clip for a ewe flock. The blue colouring of the Bluefaced Leicester is derived from the appearance of white hairs on a dark skin. An interesting feature of the breed is the occasional appearance of totally black lambs, which may be traced to certain rams. The occurrence of black lambs appears to be correlated with the intensity of blue colouring. This is the case in the Wensleydale breed, where the blue colour is more intense and the occurrence of black lambs is more common(5).

Outstanding characteristics of the breed include the prolificacy of the ewes and their excellent milking ability. Early maturity is a valuable quality in a crossing ram, especially where matings with late-maturing hill ewes are practised. The Bluefaced Leicester is not quite so early maturing as the Border Leicester, but nevertheless satisfactorily imparts the necessary degree of improvement to its progeny. Where hill ewes are served in their natural environment, the stamina of a lowland ram is severely tested, and hardiness becomes an essential characteristic. Unfortunately, it cannot be claimed that the Bluefaced Leicester is, as yet, wholly satisfactory in this respect. Experience indicates that there is a relatively high mortality during the autumn and winter months, especially when rams are used on the more exposed types of upland grazings. Breeders have suggested two reasons for lack of hardiness. Some tend to blame the unavoidable inbreeding practised in the early development of the breed for the lack of stamina in present flocks, but it seems probable that the fault lies more with the type of fleece on present sheep, rather than to close breeding many generations back. The light and open type of fleece gives the animal little protection during the stormy weather and, in particular, against driving rain. Breeders are now sacrificing this extremely bare type of fleece (desirable as it is in other respects) and an improvement in hardiness may be expected.

Whilst the number of pure-bred Bluefaced Leicester flocks is small, the breed's influence on sheep farming in the North of England is considerable because it is essentially a crossing breed. A relatively small number of rams sire many thousands of cross-bred lambs annually. The chief virtue of the Bluefaced Leicester as a crossing ram is that the majority of ewe lambs from the Blackface ewe mating, develop into a good type of commercial breeding ewe, commonly known as the Greyface or Mule. Mule ewe lambs sired by the Border Leicester ram have little of the quality of those sired by the Bluefaced Leicester, and in most cases are unsuitable for retention as breeding ewes. They have a rough, heavy fleece, light-coloured faces and legs, and a generally coarse appearance. They develop into poorer milking ewes, and for this reason are commonly sold as stores for fattening alongside the wethers. The different market open to Mule ewe lambs sired by the Bluefaced Leicester explains the superiority of this breed for crossing with Blackfaced hill ewes. Where the Border Leicester is used, lambs of both sexes can be sold only for fattening, and the price received is largely a reflection of the animal's size. If the Bluefaced Leicester is used, however, the majority of the ewe lambs can be sold for breeding, and for this purpose will realize considerably more

than their value in the store market. The wether lambs are approximately equal in value, whichever type of ram is used.

Distribution and Use South Northumberland, and particularly the Tyne Valley, is the principal breeding ground for Bluefaced Leicester sheep, although flocks are to be found throughout Northumberland, Durham and East Cumberland. In these districts the Bluefaced Leicester is the most popular crossing breed for matings with draft Blackfaced ewes. To the south, in Westmorland, Lancashire and Yorkshire, the predominant crossing breed is the Wensleydale, whose cross-bred progeny, known as Mashams, are equally useful for retention as breeding ewes or for fattening on roots during winter. In Scotland and North Northumberland, where both Cheviot and Scotch Blackface occupy hill grazings, breeders of Mule lambs have hitherto used a type of Border Leicester crossing ram similar to that which blends so admirably with the Cheviot to produce the Half Bred ewe. As has been noted above, the type of mule ewe lamb so produced is suitable only for the store market. The writers suggest that a more widespread use of the Bluefaced Leicester for this mating would lead to the production of more valuable ewe lambs suitable for retention as breeding ewes and would help to reduce the present shortage of good quality commercial breeding ewes.

The case for the increased use of the Bluefaced Leicester clearly rests upon its ability to sire more valuable Mule ewe lambs than the Border Leicester, and the future of the Bluefaced Leicester largely depends upon the demand for Mule ewes. The qualities of this type of ewe are therefore worth mentioning. Mule ewes are prolific breeders and deep milkers; the average ewe can rear twin lambs with ease. Possibly the most valuable attribute of the Mule at the present time is its thriftiness. Under marginal land conditions a satisfactory lamb crop is produced, and under lowland conditions Mules are generally more easily kept than Half Breds (Cheviot × Border Leicester). In particular, Mules are less dependent on supplementary feeding during the winter and early spring months. They are usually cheaper to buy in than the better-known Half Bred, and the consequent lower rate of depreciation makes them particularly attractive as commercial breeding ewes. While the Half Bred will probably continue to reign supreme for the very best of pastures, there is likely to be a growing demand for Mules for many grassland conditions, especially in the North of England. As the Bluefaced Leicester has an essential part to play in the production of quality Mule ewes, it would seem that this breed has an assured place in the sheep husbandry of the North of England for many years to come. Indeed the time is probably opportune for breeders to co-operate and identify their breed by the formation of a breed society flock book. The breed can rightly claim to be one of the few British breeds of sheep that is today being used primarily for the purpose for which it was developed.

Next month Mr. J. S. Hall and Mr. F. G. Baxter will describe the management of Bluefaced Leicester flocks.

References

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SPACING TRIALS WITH DRIED PEAS

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Home Grown Threshed Peas Joint Committee

THE problems of the most suitable seeding rate and drilling width for peas have formed a subject of investigation by the Home Grown Threshed Peas Joint Committee for several years. Most of the information obtained to date represents the outcome of field trials and experiments conducted since 1945 by, and on behalf of, the Joint Committee. Further evidence obtained from sources abroad supports, in general, the results of the experiments carried out in this country.

With marrowfat peas (the type most widely grown at present) current practice greatly favours a seeding rate of 16 stones per acre, though rates actually range from 9 to 22 stones per acre. Lower seedings often appear to be associated with wider row widths. The seed rate for Dutch Blue varieties usually varies from 12 to 14 stones per acre, though some farmers sow as much as 19–20 stones per acre. A typical seeding for Lincoln Small Blues is 12 stones per acre, or slightly more. A picture of the present position as regards marrowfat peas is shown in Fig. 1, the facts being based upon information obtained by the crop inspectors who examined seed crops under the Dried Pea Seed Approval Scheme—1949 harvest.*

With regard to row widths, 10-inch and 18-inch spacings seem to be the most favoured on the fenland soils, i.e., on peat, silt and skirt lands, whereas 7-inch spacing is the most common on other types of soil, e.g., loams, clays, and so on. This is shown clearly in Fig. 2.

Row width and seed rate factors are very closely associated and are sometimes interdependent. For example, with certain types of seed drills, it is not always possible to sow the desired quantity of seed per acre if the rows are widely spaced. Again, if peas are sown in rows, say, 18 inches apart, using the present very common seed rate of 16 stones per acre, the density of seeding within the actual rows will be very great, the seeds being spaced on the average, about 1 inch apart. Such close intra-row spacing is not conducive to high yields.

Deciding Factors Owing to many different and variable factors, it is extremely difficult to decide on the best row width and seed rate for the crop. In practice these factors have to be balanced one against the other in order to determine the optimum combination. The determining factors are as follows:

Soil Type and Soil Fertility. Crops sown in wide rows expose a greater area of bare land and, under dry soil conditions, such crops frequently become

* Since there is virtually no difference at present in the cultivation of dried peas, whether for seed or consumption purposes, the data presented in Figs. 1 and 2 are almost certainly representative for the *whole* area devoted to the crop.

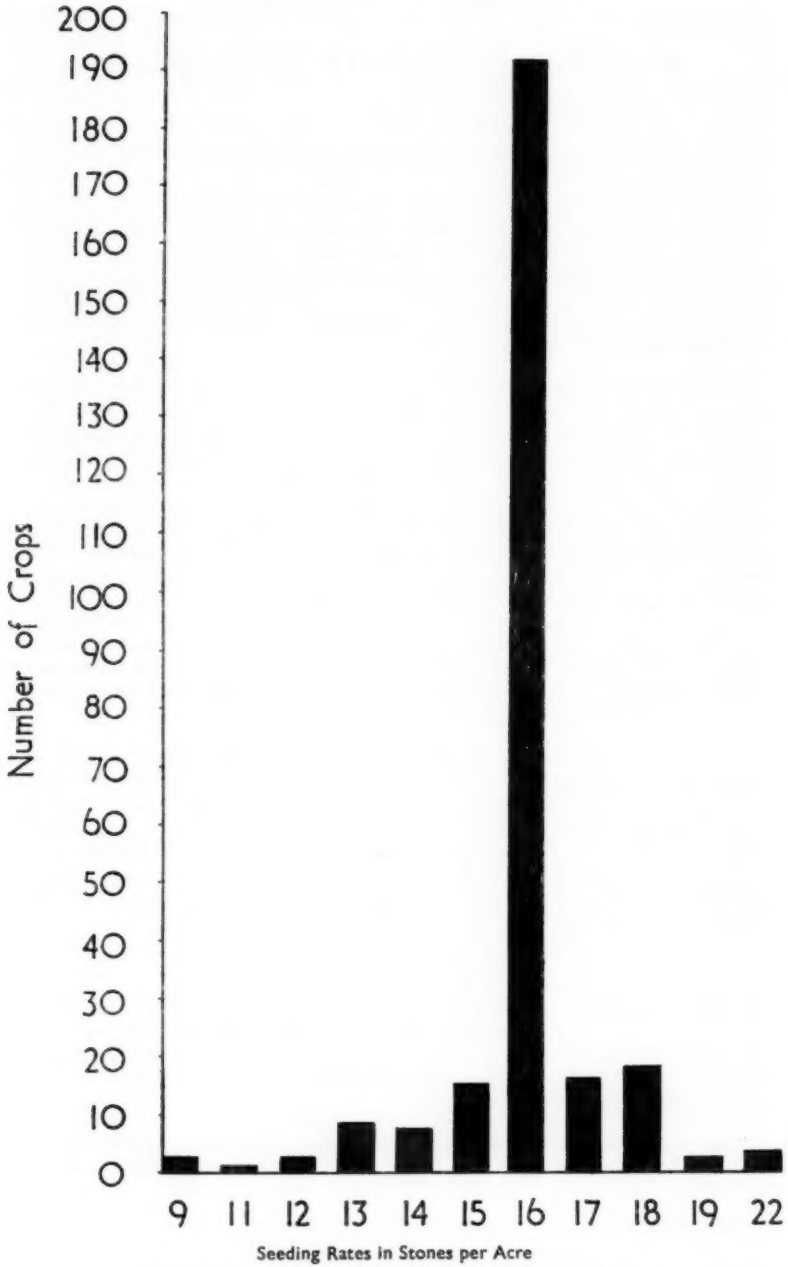

Fig. 1. Seeding Rates Used in Current Practice.

(From statistics abstracted from Field Inspection data, Dried Pea Seed Approval Scheme—1949 Harvest.)

stunted, with consequent reduction in yield. For this reason light soils and other types of soil inclined to dry out readily do not generally give good results with wide row spacing, especially with short-strawed varieties such as some of the Dutch Blue types. Land capable of conserving soil moisture is more suitable for wide row widths. Sown at a narrow row width, however, crops are able to conserve soil moisture by virtue of the shading effect of the dense vegetative cover.

Peas sown in narrow rows tend to grow a little taller than peas in wide rows. This may be of importance in relation to the fertility of the soil, since too great a length of haulm on soils of above-average fertility is undesirable.

Soil type also has a bearing on the time of sowing and, in turn, the time of sowing is one of the factors which determine the seeding rate to be used. Early-sown peas are more susceptible to attack by fungal diseases present in the soil, particularly if the seedbed is cold, wet, or in poor condition. Seed dressing will assist materially in overcoming such disorders, and the position may also be remedied to some extent by increasing the rate of seeding.

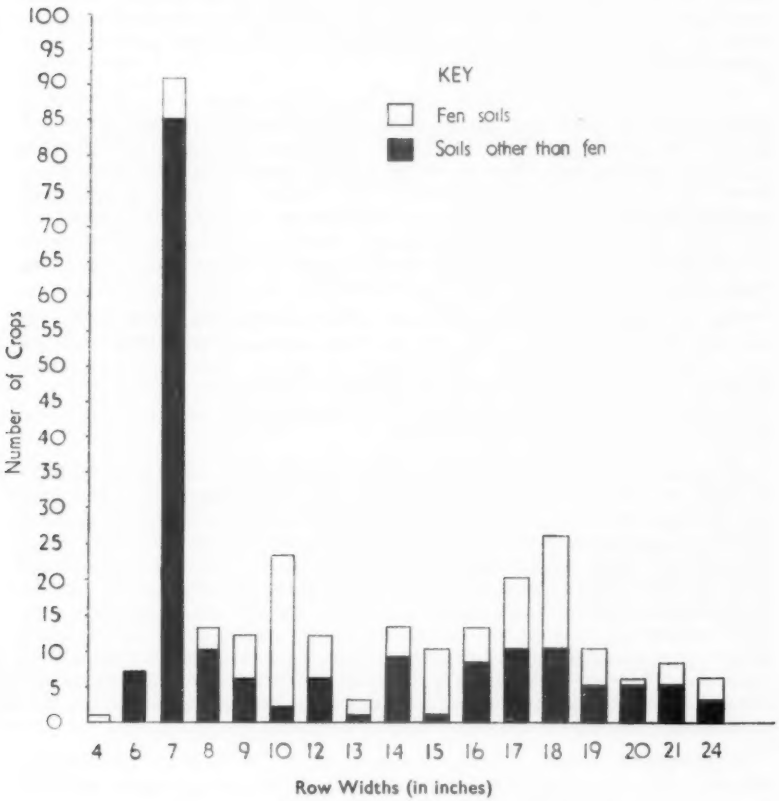

Fig. 2. Row Widths Used in Current Practice.

(From statistics abstracted from Field Inspection data, Dried Pea Seed Approval Scheme—1949 Harvest.)

Weather Conditions. In addition to the restriction of growth which drought often causes to crops sown in wide rows, the type of weather before, and following, sowing time has its effect. A greater quantity of seed per acre will be necessary if the seedbed is cold, wet, or cloddy since such conditions tend to impair germination and subsequent plant establishment.

Heavy rains and winds later in the season, especially near harvest time, often result in lodging of the crop (particularly of crops sown in wide rows) with consequent pod-splitting and staining of the peas. Moreover, "laid" crops invariably present difficulties at cutting time and considerable losses can occur through the cutting machine severing pods at, or very near, ground level.

Plenty of warm sunny weather (but not heat-waves) at flowering time and subsequently helps to ensure a good crop. If such weather prevails, the flowering period is short and a high proportion of well-filled pods is generally assured. Plants sown at a wide row width, being more exposed, are able to derive the greatest benefit from the sun and a crop of even maturity is produced. With narrow spacing, a higher proportion of undersized and undeveloped peas usually results, though the plants are less inclined to lodge since they form a dense canopy of foliage and tend to hold one another off the ground by means of their tendrils.

Variety. The choice of variety will be a factor determining the rate of seed application, since *size* of seed differs with varieties. The smaller round seed of the Lincoln Small Blue and the Dutch Blue varieties should be sown at a lower seeding rate than the large dimpled Harrison's Glory type seed, since the former have more seeds per unit weight; in other words, with varieties having small seeds, a comparable *number* of seeds will be sown per unit area by reducing the *weight* of seed sown per unit area. Further, a variety such as Unica has not the ability to cover the ground quickly; in such a case a heavier rate of seeding is desirable.

The row width has also to be related to the variety. Wide row widths are not always to be recommended for the short-strawed Dutch Blue varieties (e.g., Unica), because their dwarf habit of growth may be accentuated, particularly under dry conditions. According to Dutch literature [1, 2], Unica gives best results with thick seeding in combination with a narrow row spacing.

Time of Sowing. When sowing early the seeding rate should be more liberal in order to counteract possible attacks by soil organisms, though this may not be necessary to the same degree if the seed is dressed before sowing. Seed dressing trials have shown the benefit of this precaution, and plant-emergence counts made on a series of ten experiments over a wide range of soil types in the eastern counties in 1949 demonstrated very clearly the increased plant establishment resulting from the use of a seed protectant. At eight centres the increase was statistically very significant. Yields, too, are frequently improved by seed dressing. Of the ten experiments referred to, eight were harvested successfully, and seed dressing gave a statistically significant increase in six cases. Improved seed dressing products may well allow some economies in rate of seeding to be made.

Germinative Capacity of Seed. Obviously, if the seed is of low germinative capacity, the seeding rate must be increased. Again, seed dressing will help to annul the effect of poor germination.

Type of Seed Drill Used. The difficulty experienced with some types of seed drill in limiting the amount of seed they can sow, especially for a wide

row width, can sometimes be overcome by directing the seed from two exits of the seed drill box into one coulter ; this is usually possible with cup-feed drills. Some growers sow their peas at the same row width as for their sugar beet, so enabling mechanical hoeing to be carried out in both crops without having to adjust the position of the hoe tines.

Potential Weediness of the Land. If the land to be cropped with peas is expected to be weedy during the growing period (e.g., if the peas follow a weed-infested crop), a wide row width may be thought desirable to permit of inter-row cultivations. Many growers, however, are of the opinion that narrow spacing is the answer to weed growth, claiming that the thick, vegetative cover produced by the crop has a smothering effect. The introduction of a really safe selective chemical weed-killer for the pea crop may provide an answer to the problem.

Inter-Row Cultivations. A minimum row width of 10 inches is necessary if satisfactory mechanical hoeing is to be done during the season. Apart from the possible but doubtful secondary beneficial effects of hoeing, some growers use a wide row width to allow slight ridging-up of the rows by hoeing. It is claimed that this ridging-up is of assistance when the crop is cut with pea-cutters, which sever the stems at, or just below, soil level.

Pests and Diseases. It is conceivable that the severity of attack by pests and diseases is influenced by the row width and seeding rate ; for example, Powdery Mildew (*Erysiphe polygoni*), which attacks crops in patches, will probably do far more damage to crops sown in narrow rows.

Roguing of Seed Crops. Sowing in wide rows facilitates roguing. This is one reason why seedsmen concerned with the maintenance of purity of seed stocks prefer to place their seed with growers who make a practice of sowing in wide rows.

Harvesting Problems. Row width can affect the ease of harvesting the crop. Sown in narrow rows, the crop is better able to resist lodging, a condition which invariably interferes with cutting. Moreover, provided it is reasonably free from weeds, a crop sown at a narrow row width is more easily cut by machines having a cutter-bar, since the crop is more evenly distributed along the bar.

Spacing Trials A number of experiments has been conducted in recent years to ascertain the optimum row width and intra-row spacing for peas under various conditions. Some of these experiments have yielded very interesting and useful information. In 1946 a small-scale replicated trial was laid down to compare the effects of sowing peas in plots with 8-, 16- and 24-inch row widths in all combinations with spacings of 1, 2 and 3 inches *within* the rows. Plots each comprised four rows 12 feet long, the individual plot area varying according to row width. The trial was kept free from weeds throughout the season by periodic hand-hoeing. At harvest time the two outer rows of each plot were discarded, together with 1 foot from the ends of each plot. The data obtained were therefore based on two 10-feet rows (i.e., 20 feet of row) per plot.

For each of the nine different combinations, the following data were obtained :

Number of stems (main stems and ground-level branches).
Number of pods.
Weight of peas.

From these figures the following were then calculated :

Number of pods per stem.
Weight of peas per 100 pods.
Weight of peas per 100 stems.

The average values of these data (i.e., based on the number of replications) with the corresponding figures obtained from repetitions of the trial in 1947 and 1948 (duplicated on contrasting soil types) are presented in Table 1. The figures quoted for "Number of stems", "Number of pods", and "Weight of peas" are not based on a standard area, but are, as said before, the values obtained from plots consisting of two 10-feet rows, *irrespective of row width.*

Table 1 reveals the trend for wider rows to produce more stems per sown seed, though statistically the results were not significant for three out of the four trials. Wider spacing *between* seeds, however, significantly decreased the number of stems—a fact not unexpected, considering that the 3-inch spacing received one-third as many seeds as the 1-inch spacing. Bearing this in mind, the reductions in numbers of stems with wider intra-row spacing were not so great as the relative reductions in the seeding rates used, i.e., there was apparently partial compensation.

Wider rows and wider spacing within rows also led to more pods per stem, and the weight of peas per stem and per plant increased considerably with wider spacing between rows. The "Weight of peas per 100 pods" and the "Weight of peas per 100 stems" generally seemed to be unaffected by row width, though in 1946 they both showed a significant increase with wider row spacing. Wider spacing within the rows tended to increase the "Weight of peas per 100 pods" and the "Weight of peas per 100 stems". Probably the most interesting points to note in Table 1 are that wider spacing clearly increased the yield per seed sown, and that for a given row width, reducing the seeding from 240 to 120 or 80 seeds by sowing at 2 inch or 3-inch spacing instead of 1-inch, resulted in no depression in yield, but rather the reverse.

Transforming the figures *per* 20 *feet of row* in Table 1 into comparative figures *per acre* gives the relative values shown in Table 2. These figures, based on *area*, are more important from the practical standpoint, since, compared with 8-inch rows, an acre will contain only half as many rows at 16 inches apart and only one-third as many 24-inch rows. This Table indicates that the number of stems decreased with wider spacing, both between rows and between seeds, but that the proportionate decrease was far less than the reduction in the number of seeds sown. The mean figures show that there was a decrease in the number of pods and the weight of peas with wider inter-row and intra-row spacing. This decrease was only slight, however, in relation to the seeding rates used, and demonstrates clearly that with wider spacing the plants were able to compensate to a great extent for the larger spaces between them. In 1946 and 1948 (I) there was actually an increase in the number of pods and the weight of peas for wider spacing, but in 1947 (a very dry season), and 1948 (II) (land inclined to dry out readily), the reverse was the case. No doubt the drought conditions restricted development on the wider rows and thinner sown plots. The proportionate decrease in the number of stems was also greater under dry conditions.

But the farmer is primarily concerned with *yield per acre.* Expressed in terms of cwt. per acre, the average yields and the mean yields for the different sowings are given in Table 3. The yields for each experiment and the mean yields for the four experiments indicate the trend for the 8-inch row width to outyield the 16-inch and 24-inch row spacings. In 1947 the 8-inch spacing yielded significantly more than the other row widths. In the other trials yields for the nine different treatments were, statistically, as good as one another, indicating that a seeding rate of 4.2 stones per acre (24-inch row spacing with 3 inches between seeds), produced as good a yield as did a seed rate of 38.0 stones per acre (8-inch row spacing with 1 inch between seeds), a seeding rate nine times as large. Although little importance can be attached to this result, owing to insufficient replication of each experiment and varia-

Table 1

Average Values for Different Sowings

Distance between rows:		8 inches			16 inches			24 inches			Size of difference to be statistically significant at 5 per cent probability point.	
Distance between seeds within rows:		1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	Between row widths.	Between spacings within rows.
		No.	No.	No.	No.	No.	No.	No.	No.	No.		
1. No. of stems per 20 ft. of row:	1946	128.5	118.5	89.0	175.5	156.5	124.5	201.5	169.5	149.0	20.83	21.04
	1947	120.0	79.0	64.0	121.5	97.0	74.0	155.0	101.0	126.5	Insig.	18.48
	1948 (I)	114.0	66.5	70.5	147.5	90.0	75.5	172.5	115.5	79.0	Insig.	37.13
	1948 (II)	189.0	103.0	93.0	224.5	112.5	76.5	222.0	138.0	97.5	Insig.	14.52
Mean:		**137.9**	**91.8**	**79.1**	**167.3**	**114.0**	**87.6**	**187.8**	**131.0**	**113.0**		
2. No. of pods per 20 ft. of row:	1946	369.0	448.5	406.5	736.5	879.5	910.5	1205.5	1209.0	1121.0	105.26	Insig.
	1947	420.0	385.0	384.0	581.0	616.0	466.0	739.0	781.0	927.0	191.63	Insig.
	1948 (I)	275.5	309.0	306.0	566.5	583.0	566.0	867.0	798.0	581.5	125.42	Insig.
	1948 (II)	441.5	466.5	385.0	670.5	666.0	533.5	884.0	927.0	766.0	156.41	Insig.
Mean:		**376.5**	**402.3**	**370.4**	**638.6**	**673.6**	**619.0**	**923.9**	**928.8**	**848.9**		
3. Wt. of peas per 20 ft. of row:		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.		
	1946	13.0	15.5	14.0	25.0	29.5	35.0	45.5	45.5	46.0	5.03	Insig.
	1947	12.0	12.7	15.5	18.5	23.4	18.0	25.9	26.2	31.6	9.36	Insig.
	1948 (I)	7.4	9.5	7.4	15.5	16.3	17.8	22.6	23.1	17.3	Insig.	Insig.
	1948 (II)	8.6	12.3	11.6	15.3	16.8	12.6	19.8	24.8	22.8	6.96	Insig.
Mean:		**10.3**	**12.5**	**12.1**	**18.6**	**21.5**	**20.9**	**28.5**	**29.9**	**29.4**		
4. No. of pods per stem:		No.	No.	No.	No.	No.	No.	No.	No.	No.		
	1946	2.85	3.80	4.55	4.15	5.60	7.40	5.95	7.15	7.55	1.68	1.25
	1947	3.50	4.90	6.00	4.90	6.40	6.30	4.70	7.60	7.40	1.07	1.83
	1948 (I)	2.50	4.90	4.40	3.90	5.90	7.60	5.10	7.10	7.50	0.96	1.52
	1948 (II)	2.40	4.50	4.30	3.00	5.96	7.00	3.90	6.80	7.90	1.04	1.27
Mean:		**2.81**	**4.53**	**4.81**	**3.99**	**5.95**	**7.08**	**4.91**	**7.16**	**7.59**		
5. Wt. of peas per 100 pods:		oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.	oz.		
	1946	3.50	3.45	3.45	3.40	3.35	3.85	3.80	3.75	4.15	0.18	0.16
	1947	2.80	3.30	4.00	3.10	3.80	4.00	3.50	3.30	3.40	Insig.	0.24
	1948 (I)	2.60	3.00	2.40	2.70	2.90	3.10	2.50	2.80	2.90	Insig.	Insig.
	1948 (II)	1.90	2.60	3.00	2.30	2.50	2.40	2.30	2.70	2.90	Insig.	0.23
Mean:		**2.70**	**3.09**	**3.21**	**2.88**	**3.14**	**3.34**	**3.03**	**3.14**	**3.34**		
6. Wt. of peas per 100 stems:	1946	10.00	12.50	15.50	14.00	18.50	29.00	47.00	58.00	75.50	6.76	4.63
	1947	10.00	16.00	24.50	16.00	24.00	25.50	17.00	25.50	25.00	Insig.	0.46
	1948 (I)	6.60	15.00	10.40	10.40	17.80	23.60	12.90	23.50	22.00	Insig.	Insig.
	1948 (II)	4.60	11.70	12.90	6.80	14.80	16.50	8.90	18.10	23.70	Insig.	Insig.
Mean:		**7.80**	**13.80**	**15.83**	**11.80**	**18.78**	**23.65**	**21.45**	**31.28**	**36.55**		
No. of seeds sown per 20 ft. of row:		240	120	80	240	120	80	240	120	80		

Table 2

Relative Values per Acre

(8 in. × 1 in. = 100)

Distance between rows:		8 inches			16 inches			24 inches		
Distance between seeds:		1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	1 in.	2 in.	3 in
No. of stems:	1946	100	92.2	69.2	69.5	60.8	48.4	52.2	43.9	38.6
	1947	100	65.8	53.3	50.6	40.4	30.8	43.0	28.0	35.1
	1948 (I)	100	58.3	61.8	64.7	39.5	33.1	50.4	33.8	23.1
	1948 (II)	100	54.5	49.2	59.4	29.8	20.3	39.2	24.3	17.2
Mean:		**100**	**67.7**	**58.4**	**62.1**	**42.6**	**33.2**	**46.2**	**32.5**	**28.5**
No. of pods:	1946	100	121.5	110.2	99.8	119.2	123.4	108.9	109.2	101.3
	1947	100	91.7	91.4	69.2	73.3	55.5	58.6	62.0	73.6
	1948 (I)	100	112.1	111.1	102.8	96.7	102.7	104.9	96.5	70.4
	1948 (II)	100	105.6	87.2	75.9	75.5	60.4	66.7	69.9	57.4
Mean:		**100**	**107.7**	**100.0**	**86.9**	**91.2**	**85.5**	**84.8**	**84.4**	**75.8**
Wt. of peas: (oz.)	1946	100	119.2	107.7	96.2	113.5	134.6	116.5	116.5	118.1
	1947	100	105.8	129.1	77.1	97.5	75.0	71.9	72.8	87.7
	1948 (I)	100	128.8	100.0	105.1	110.3	120.3	102.2	104.6	78.0
	1948 (II)	100	140.0	134.8	88.4	97.1	73.2	76.3	95.6	87.9
Mean:		**100**	**123.5**	**117.9**	**91.7**	**104.6**	**100.8**	**91.7**	**97.4**	**92.9**
No. of seeds sown:		100	50	33.3	50.0	25.0	16.6	33.3	16.6	11.1

tion within them, the results do suggest that some economies in seeding may be practicable. The figures also indicate that for a given seeding rate, narrower row spacing produced the highest yield, presumably because in narrow rows the plants have more space *within* the rows in which to develop, whereas in wide rows the inevitable thick intra-row seeding hampers development.

Table 3

Yields for Different Sowing Rates

Distance between rows:		8 inches			16 inches			24 inches		
Distance between Seeds:		1 in.	2 in.	3 in.	1 in.	2 in.	3 in.	1 in.	2 in.	3 in.
Equivalent yield in cwt. per acre:	1946	23.7	28.2	25.5	22.7	26.8	31.8	27.7	27.7	28.0
	1947	21.8	23.2	28.2	16.8	21.3	16.3	15.8	16.0	19.3
	1948 (I)	13.4	17.3	13.4	14.1	14.8	16.2	13.8	14.1	10.5
	1948 (II)	15.7	22.3	21.2	13.9	15.2	11.5	12.0	15.1	13.9
Mean:		**18.65**	**22.75**	**22.08**	**16.88**	**19.53**	**18.95**	**17.33**	**18.23**	**17.93**
Equivalent rate of sowing: (Stones per acre)		38.0	19.0	12.6	19.0	9.5	6.3	12.6	6.3	4.2

Table 3 also shows that for each row width the 2-inch intra-row spacing yielded best. This can be illustrated to better advantage in another way, namely, by making the 2-inch intra-row spacing the standard for each of the three row widths, and indicating for each row width whether the 1-inch and 3-inch spacings resulted, by comparison with the 2-inch spacing, in a yield increase (+), a further increase (+ +), a decrease (—), or a further decrease (— —). The result is as follows:

Row width	8 inches		16 inches		24 inches	
Spacing within rows ..	1	3	1	3	1	3
Year						
1946	— —	—	—	+		+
1947	—	+	— —	—	—	+
1948 (I)	—	—	—	+	—	— —
1948 (II)	— —	—	—	— —	— —	—

This reveals clearly that the 1-inch (particularly) and 3-inch spacings produced a lower yield by comparison with the 2-inch spacing, and that the optimum spacing between seeds *within the row* lies at slightly more than 2 inches.

Other Row-width Trials Since 1945, yield figures have been secured from nineteen row-width trials sponsored by the Joint Committee, exclusive of the small-scale spacing trials just described. These trials have ranged from properly replicated experiments comparing three row widths with a constant rate of seeding per acre for all treatments, to simple trials comparing two parts of a field sown with the same quantity of seed per acre at two different row widths. Results have been very conflicting, and there has been no obvious correlation between yield and row width. Soil type by itself does not appear to determine the most suitable row width so far as yield is concerned, as may be shown by grouping the highest yields obtained for the various row widths, in relation to the different soil types on which the trials were carried out :

	No. of Trials* giving Highest Yields with a		
Soil Type	Narrow Row width (7–8 *inches*)	Medium Row width (14–16 *inches*)	Wide Row width (21–22½ *inches*)
Clays and heavy loams	7	2	1
Medium, light and chalky loams	2	2	1
Fenland silt	1	1	—
Fenland skirt	—	1	—
Total ..	10	6	2

This again demonstrates quite obviously that it is the interaction of a number of factors which determines the optimum row width, and it is probably true to say that weed competition plays a very important role in this respect. For example, in a weed control experiment on peas in 1948, one chemical weed-killer resulted in a 30 per cent increase in yield over untreated plots. It is highly probable that in the majority of the nineteen trials mentioned, the row widths giving the greatest yields were the least weedy ; in the case of wide rows this could be attributed to inter-row cultivations, and with narrow rows to the thick vegetative growth preventing weed development.

Seeding Rate Trials From the small-scale spacing trials referred to earlier, there appears to be a strong case for reducing the conventional rates of seeding used in current practice. In regard to marrowfat peas, provided a seed dressing is used, the seed is sown reasonably early, and that weeds are controlled by hoeing or chemical treatment, it should be feasible under average conditions to sow at a rate of less than 16 stones per acre. Seeding rates in excess of 16 stones per acre for marrowfat peas would seem to be unwarranted, unless, perhaps, harrowing is carried out when the peas are a few inches high in order to kill seedling weeds. Even then 16 stones per acre should be more than adequate as a rule.

Results of ten seeding rate trials of various designs carried out in 1946–49, some replicated and some non-replicated, gave the following yield results in relation to soil type and rate of seeding :

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* Details relate to eighteen trials. The remaining experiment compared two varieties (namely, Harrison's Glory and Mansholt's G.E.K.) at three row widths. Harrison's Glory yielded highest in 14- and 21-inch rows, whilst Mansholt's G.E.K. gave highest yields in 7-inch rows.

	No. of Trials* giving Highest Yield with a		
	Low Seed rate (10–14 *stones per acre*)	**Average** Seed rate (15–18 *stones per acre*)	**High** Seed rate (19 *stones per acre*)
Clays and heavy loams ..	—	1	1
Medium, light and chalky loams	3	2	—
Fenland silt	1	1	—
Total ..	4	4	1

Foreign Work Research in Holland (2) has led to the conclusion that narrow row widths with *heavy* seed rates give the highest yield results. This was especially apparent with the variety Unica which does not possess the characteristic of matting together as do certain other varieties. It is pointed out, however, that on fertile soils which produce strong growth, a lower rate of seeding than average is usually sufficient.

In another Dutch publication (3) it is contended that, generally speaking, the correct rate of seeding is being used in Holland but that final plant establishment is bound to vary from year to year. Figures from trials show that the best yields are obtained with narrow row widths in conjunction with heavy seeding rates. It is also mentioned that narrow spacing between rows tends to produce taller plants, a fact which may be of importance on soils which produce stunted crops.

Spacing experiments in Holland (3) carried out on similar lines to the small-scale spacing trials in this country, confirm our results. As here, the Dutch experiments showed that a greater number of pods and peas per plant was produced by wider spacing, and that the number of peas per pod was also increased, but not to the same extent. As with our experiments, however, the yield *on an area basis* decreased with wider spacing between rows.

Sayre (4) in the U.S.A., besides presenting data to show that more plants per unit-quantity of seed germinate and survive if the seed is dressed with a seed protectant†, also quotes results of tests to compare different sowing rates. These figures again confirm our results in revealing that there is a decrease in the number of pods per stem as the density of plants increases, the diminishing return presumably being mainly due to competition for soil nutrients and soil moisture. Sayre refers to trials in which a seed rate of 3 bushels‡ dressed seed per acre yielded more than did those of 4 or 5 bushels of dressed seed, the seeding rates normally used.

These trials in Holland and the U.S.A. support our findings in illustrating that, with wider spacing, the individual plant compensates by producing a greater number of pods and peas, i.e., the yield *per plant* is increased.

That spacing is influenced by the variety of pea to be grown is confirmed by other trials carried out in the U.S.A. (5) over a three-year period, and designed to discover the ideal spacing for accurate yield comparisons between varieties of *canning* peas. These trials resulted in a significant interaction between varieties and spacings, thus indicating that varieties react differently to various spacings.

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* Details relate to nine trials. The remaining experiment compared two varieties (namely, Harrison's Glory and Mansholt's G.E.K.) at 14, 11 and 5, and 14, 10 and 6½ stones per acre respectively. The best yields were obtained for Harrison's Glory at the medium rate (11 stones per acre) and Mansholt's G.E.K. at the lower rate (6½ stones per acre).

† In this instance an American proprietory product containing tetrachloro-para-benzoquinone.

‡ U.S.A. measure.

Conclusions From the results of the trials mentioned in this article, it is impossible to recommend a particular row width, since this is influenced by so many factors. A decision must be made by comparing the factors in favour of a narrow row width with those for a wide row width. Data obtained from the small-scale spacing trials described definitely suggest a distance between seeds *within* the row of 2 inches, or slightly more, but less than 3 inches—and *irrespective of row width.*

If the seed is treated with a reputable seed protectant before sowing, and appropriate measures are taken against pest attacks and weed development, should they occur, it seems certain that the conventional rates of seeding used in current practice could be reduced, while still maintaining as good a yield.

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A WORKSHOP FOR THE SMALL FARM

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THE farmer who takes care of his machines takes care of his capital. There are three principal requirements: 1. A building, or part of a building, into which implements may be brought for attention; 2. A workshop in this building, with accommodation for essential spares; 3. A cleaning bench and paraffin bath, where components can be stripped, degreased, and prepared for the fitting bench.

With these facilities a farmer or one of his workers of average mechanical ability should be able to undertake satisfactorily the care and maintenance of farm machines and so postpone the need to call on an outside firm for major overhaul and replacements.

The value of a workshop, suitably situated, and where there is a place for everything and everything is in its place, cannot be over-emphasized. There are many advantages in bringing the implement to the tools, rather than taking the tools to the implement: work can be done under cover, walking time is reduced, and all the tools are ready to hand.

The equipment and tools shown in the illustration (p. iv of the art inset) should be sufficient to meet the requirements of the ordinary small farm in this country where, perhaps, power is not available. Acreage and type of farm will decide the number and kind of implements necessary, but for the moment, let us consider the tractor, mower, binder and plough.

Bins for the accommodation of spare parts may be of rough timber. Inside the drop-front of the bins a card should be attached showing its contents, and there should be a space for withdrawals, so indicating when further supplies are needed. With this kind of system an important job will not be held up for want of a spare. One cannot always depend upon the local merchant to meet an emergency.

Another advantage of having everything properly labelled is that if a part should be required at short notice for an implement at work in the field, a farm hand, however new he may be, can be sent back with exact directions where the part may be found. Time spent in searching for what may be "a needle in a hay stack" is time lost.

The cleaning bench, shown beside the spares bin, will be of real value and is easily constructed with rough timber. Here rusty parts may be readily degreased and cleaned by immersion in paraffin in a gauze tray. Apart from cleaning the components before working on them, the full extent of the wear and the need for adjustments or painting are revealed.

It will be seen from the illustration that a stand for paint, brushes and turpentine has been included, and this raises the important point of rust prevention. It is well known that rust and corrosion shorten the life of a machine considerably, yet the protection of stationary parts of machinery is comparatively simple and requires little beyond cleaning off any rust already present, and the application of good quality paint. Moving parts subject to abrasion and friction in operation, such as mouldboards and cutter-bars, need the application of a rust preventive when the surfaces are clean, dry and polished.

One point with regard to lubrication may be mentioned, since it is not always referred to in makers' instruction books: in binders, the eyes (or leads) through which twine is led from the can to the needle should be filled with grease to prevent rust, otherwise the friction consequent upon the rust increases tension, sometimes resulting in broken twine. It is a good plan to pull the twine several times backwards and forwards through the leads to remove rust and ensure that tension is applied only at those points where it is intended.

De-watering fluids are being developed, but their availability and suitability for general farm use require further investigation before any recommendation can be made. A number of materials are available; some are difficult to apply, some are difficult to remove, and some suffer from both defects. A good mineral jelly, applied with a stiff brush, will give good temporary protection, particularly if the implement is stored under cover. The jelly may be removed by vaporizing oil or paraffin, neither of which, it should be noted, is, in itself, a lubricant. The use of sump oil is not recommended. In 1946–47 the National Institute of Agricultural Engineering tested this amongst a number of other lubricants for rust prevention over a period of twelve months, and it was found that the protection given by sump oil was negligible. Soft, semi-solid grease was also investigated and found to be little better; protection was poor, and the grease was liable to run in the summer, or to form scales. All that could be said in its favour was that it was easily removed.

THE FUTURE OF SOILLESS CULTURE

C. E. TICQUET

Hon. Secretary, Soilless Culture Society

SINCE the spectacular achievements of the Americans in growing crops without soil on a large scale during the war, interest in the possibilities of this method of horticulture has received a new impetus. Before suggesting whether or not this interest should be encouraged, a review of the past development of nutrient-solution culture may help in understanding the position today.

FUTURE OF SOILLESS CULTURE

For the purpose of discussion, soilless culture can be divided into four periods:

1. The laboratory stage
2. The first commercial development
3. War-time expansion
4. The post-war period

The laboratory stage is too well known to call for recapitulation. From John Woodward's classical experiments with spearmint, published in 1699, right up to the present time, growing plants in jars of solution or sand has been the usual method employed by plant physiologists.

Although the suggestion had been made by W. R. Robbins of New Jersey a year or so before, it was left to Dr. W. F. Gericke in California to effect the great step of taking water culture out of the laboratory into the greenhouse and garden. His remarkable results attracted much interest and many converts. Experience in Britain has not fulfilled the promise of those early days, and it is generally believed now that, whatever might have been achieved under the Californian sun, the climate here is against any noteworthy increase in yield from water culture as compared with ordinary soil culture. Because of this, and the difficulties of proper aeration of the solution, as well as supporting the plants in the loose bedding specified in the Gericke method, the Doctor's following declined.

The Sub-Irrigation Method Fortunately for those who still believe in the possibilities of soilless culture, a new method (sub-irrigation) was evolved which overcame many of the difficulties of the water-culture system. This method was the first to be taken up on a really commercial scale. The water-tight beds were retained, but were filled with gravel, cinders, or some other inert material. They were then pumped periodically with nutrient solution, usually from storage chambers below. Two of the chief difficulties—aeration and plant support—were thereby overcome. The air-filled cavities aerated the solution, and the gravel or cinders supported the roots. But at the same time, other disadvantages were introduced in the form of expensive pumps and piping, and excavation for storage tanks.

In practice, improvements were evolved which eventually removed two of the major objections. By building large tanks above ground and feeding the plants by gravity, the size of the pumps needed was reduced to a minimum, since instead of having to force solution into the beds in a comparatively short time, they need only be powerful enough to transfer the nutrient from the lower to the upper storage tank in time for the next feeding—a matter of up to eight hours. Piping was reduced, since beds were built in terrace formation, and the solution flowed through these one after the other. Above-ground tanks also avoided the need for large excavations, the drainage sump and pump pit being the only component parts below ground level. A further modification provided open flumes (or channels) instead of piping, and this system is being used successfully in several large installations today.

These improvements were responsible for renewed interest in soilless culture before the outbreak of war in 1939. This interest was very much greater in America than in this country, although by this time Professor R. H. Stoughton, of Reading University, and Capt. S. R. Mullard of Englefield Green, together with one or two other pioneers, were already beginning the series of trials which were to be the foundation of what we know of the practical and commercial aspect of soilless culture in this country today.*

* See article "Nutrient Solution Culture of Crop Plants" by Professor Stoughton. *Agriculture*, **53**, 539-47.

Soilless Culture in War-time With the outbreak of war, however, materials, chemicals, and labour became scarce and expensive. and progress was halted. The system might have gone back to the laboratory but for the extension of the war to the Far East. Difficulties of providing troops scattered in tropical outposts with fresh vegetables led the United States Air Force to take up hydroponics as a means of saving expensive shipping. Early in 1945 the first installation was established on Ascension Island—a particularly difficult place on which to start, since the only water available was crudely distilled sea water. On the other hand, it was an ideal place to prove the value of the system, since the only soil was a small pocket near the top of the volcanic rock of which the island is largely composed.

Results were encouraging. Close on 100,000 lb. of vegetables (chiefly tomatoes, lettuces and cucumbers) were produced during the first year. A few months later a second installation was built in British Guiana, take-off point for the transatlantic aircraft. This contained 75 beds—three times the number on Ascension. This time the yield in the first full year of operation (1946) was nearly 240,000 lb. For the first time, too, detailed costs were available. One example quoted was cucumbers, which cost four cents a pound to produce. A third installation was begun, again in 1945, at Iwo Jima ; and the decision was also made to begin the world's biggest installation in Japan.

The Japanese venture, on two separate hydroponic farms, comprised a total of 80 acres. The undertaking was so large that it warrants description in some detail. The farms were made up of units of 5 acres, each containing 87 beds covering an area 300 feet by 4 feet. According to the standard practice established by that time, the beds were in series of three sections, the first 120 feet long, the second 100 feet, and the third 80 feet. By this means, allowance was made for absorption and evaporation as the solution flowed through each bed in turn, the reduction in area ensuring that each succeeding section received full measure. One unit at Chofu, Tokyo, was under glass ; the others (as were all those at the other farm at Otsu) were in the open.

Completion of this great enterprise was the last task carried out by the nutriculture section of the USAAF. The end of hostilities and demobilization made further development unnecessary, and by the end of 1946 the production of fresh vegetables by soilless culture for the air force was largely a matter of history.

But various vital decisions had been reached. Chief among them was that large-scale operations were not only feasible, but successful. Another was that where there is no soil, or where that available is so impoverished or disease-ridden as to be useless, soilless culture fills a definite gap. Many other lessons regarding the practical applications were of course, learned, but are too detailed to be given here.

The Post-War Period The post-war period, broadly speaking, has confirmed war-time experience—that the obvious places for development are in tropical or semi-tropical areas. In Florida, U.S.A., some 20 or 30 installations produce vegetables and flowers on a commercial scale. On the islands of Aruba and Lago, oil companies operate installations for the benefit of their employees. In the northern United States, greenhouse concerns grow food and ornamental crops for marketing. On the whole, however, the high cost of building installations at present-day prices discourages a good deal of development that might otherwise take place.

In Britain, soilless culture, as is natural in view of the location of the principal centres of the glasshouse industry, is carried on chiefly in the south.

Several firms in Sussex, and one or two in Devon and Cornwall, are operating successfully on a commercial scale, chiefly growing carnations, tomatoes, and early sweet peas. Because of the simpler and cheaper installation, there is a tendency for sand culture to be preferred, though, as the nutrient drains away, this is the least economical method from the point of view of salts used. A prominent horticultural firm in Berkshire, with 10 acres of sand culture, operates the largest unit of this kind.

On the whole, however, the method has touched only the fringes of the industry, a situation for which three factors are chiefly responsible :

1. The heavy cost of installation
2. The lack of trained staff
3. The natural fertility of our soil

Of these perhaps only the last needs elaboration. It is a fact that on a commercial scale yields obtained by soilless culture are not outstandingly bigger or better than those from soil. On the other hand, labour costs are lower, fertilizers are used more economically, and there is a saving on soil-changing and sterilizing. But the compelling argument is crop yield.

If our soil were poorer, or if there were arid areas, soilless culture would probably already have been an established industry here. As it is, soilless culture has to meet normal competition : it cannot produce what the soil cannot, as in Ascension Island ; it cannot guarantee disease-free crops, as in Japan ; it cannot save shipping cost, as in Iwo Jima ; it can only be said in effect : If you take the trouble to master the method it will give you just as good crops, more consistently and at reduced operational costs.

Future Possibilities Unless, therefore, costs of equipment fall appreciably, large-scale development commercially in this country in the near future is unlikely.

In the meantime, extension is largely in the hands of amateurs. Foremost among those interested is probably Mr. W. Doxford, of Eastergate, Sussex, who first suggested the present methods of analysing nutrient solutions, using colour discs. Inspired by his work, members of the Soilless Culture Society are collecting and collating information on the adsorption of elements on the particles used in aggregate culture, a vital factor not previously taken seriously into account, and one responsible for a good many undiagnosed failures.

It is through these channels possibly that experienced operators will come, if and when they are required. Through them, too, may come the adaptations or even discoveries which may make soilless culture a better proposition from the average nurseryman's point of view.

In the Commonwealth it is a different story ; there the prospects are already great. In the Bahamas, where the soil is so thin and impoverished that in places crops have to be moved to fresh ground every year, soilless culture is at present being tried, and is likely to develop. In West Africa, and parts of East Africa, where substantial white populations live in areas of poor or pest-ridden soil, fresh food produced in this way would be a boon. At stations along remote air routes it would be equally appreciated, and this of course has not escaped the attention of the responsible authorities.

The greater ease of nutrient control, the freedom from soil-borne trouble, the consistent results, the saving in labour, water and fertilizers, and the educational value of being able to observe and correct deficiences and excesses immediately, are all factors likely to ensure the ultimate development of soilless culture. For high-class greenhouse crops the prospect is already fairly clear. For food crops the issue depends on the general food and population situation of the world.

FARMING AFFAIRS

Crop Conservation Conference A highly successful two-day conference on crop conservation, the report of which has now been published,* was held in London last May, under the auspices of the National Farmers' Union. Opening the Conference, the Minister of Agriculture commended the N.F.U. on the comprehensive nature of the programme, and stressed that crop conservation is a vital factor in the livestock expansion programme which necessitates making the fullest use of grass as a crop. The need for better grazing, hay, silage and dried grass is of the utmost importance in the present national position, and the keynotes are high production from every acre of land now under grass, and the conservation of surplus material in the most efficient manner.

Mr. Maitland Mackie explained the ley farming system he himself practises. He covered the all-important points of what to sow, how and when to sow it, and the manuring and subsequent treatment of the crop. The most important thing is to become enthusiastic about growing better grass; then the crop would be well treated in its production, management and utilization. Mr. W. R. Muir spoke of the feeding value of conserved crops, with special reference to hay, dried grass and silage. He gave detailed statistics to show the wide range of variation in the quality of these foods, with valuable advice on the best way of utilizing them in the interests of higher output of livestock products.

Professor H. Ian Moore dealt with haymaking, the oldest method of conservation, and spoke on how to reduce losses in the process. He regarded increased mechanization as a potent factor in making better hay, but emphasized the all-round need for intelligent and wise management of the crop, and of the meticulous care needed to ensure the conservation of the maximum yield of nutrients per acre.

Mr. J. S. Morrey spoke of the place of grass drying on his farm. Here drying is fitted into the general farming system, solely as a means of dealing with material surplus to the immediate requirements of the stock. The grass is subservient to the livestock, and the criterion of measuring production per acre is not in terms of tonnage of grass, but of production of livestock and milk sold off the farm. Mr. Rex Paterson then spoke of his system of using the buckrake to make wilted grass and leguminous crops into silage, and Mr. Eric Rea explained the place of silage-making on the small farm and gave some golden rules for success.

Co-operative grass drying was dealt with by Mr. T. Hollins, who gave a paper on his experiences during 1948 as a manager of a co-operative drying plant, the difficulties that arose and how they were overcome. Mr. Inglis discussed the general problems associated with co-operative grass drying, from the technical to the economic aspects of the subject, and affirmed his faith that efficient utilization of grass is the key to economic milk production.

East Malling Research Station 1948 Report The East Malling Research Station's Annual Report for its thirty-sixth year (1948) follows the same general pattern as that for previous years, with the addition of a short tribute to the retiring Director, Sir Ronald Hatton. It is arranged in four parts.

Section I contains the farm report, which outlines the treatment of the various plantations and fields and gives particulars of the crops. On the whole, the season was favourable for the research farm.

Section II reviews the progress of the research programme as a whole and contains a list of the publications issued by the Station during the year. The

* Free from the National Farmers' Union, 45 Bedford Square, W.C.1.

programme covers all the main problems of fruit-growers, and the results show that very interesting advances are being made.

Section III contains the research reports. These are written mainly for scientific readers but are of interest also to the progressive fruit-grower, as they enable him to keep up to date with the very latest advances. The weather report for the year appears in this part of the Report.

Section IV is specially written for the non-scientific reader and contains articles giving the practical results of the research or interesting details of how the work is done. The section also includes full details of the arrangement of the experimental plantations, with a diagram of the lay-out.

The complete Report is sent free to subscribing members of the East Malling Research Station Association, and can be obtained by others from the Secretary, East Malling Research Station, near Maidstone, Kent, price 10s.

Hop Research For more than half a century Wye Agricultural College, in association with the East Malling Research Station, has conducted investigations into the problems concerned with hop growing. When the College reopened in 1945, after the war period, arrangements were made to reconstitute the Hop Research Department which has now become a joint responsibility of the Ministry of Agriculture, the Hops Marketing Board and the Institute of Brewing. The Hop Research Department of the College will serve the growers and the industry generally as the central authority for investigation and research work; research on pathological problems will continue at the East Malling Research Station in collaboration with the College.

The decision to issue an Annual Report on the work of the Hop Research Department will be welcomed generally. The Report, published in April, 1949, covers the period from March, 1947, to March, 1948, but it contains much useful information derived from past investigational work and so is particularly valuable to all who are interested in hop culture. Manurial, cultivation and breeding investigations have been carried on for many years, and recently the Department was called upon to investigate the relation of soil conditions and plant nutrition to the incidence of *Verticillium* Wilt, one of the worst troubles the grower has to contend with.

The production of new and better varieties of hops is a particularly complex problem because of the dioecious character of the plant (all cultivated hops are female clones), and calls for the attention of trained geneticists. The staff of the Hop Research Department will ensure that adequate attention is paid to the genetical side of the hop breeding work instituted at Wye over thirty years ago by Professor E. S. Salmon. An interesting feature of the Report is an article by Dr. S. O. S. Dark entitled *The Hop Breeder's Problem.* Included in this Report, which is obtainable from the Secretary, Wye College, Ashford, Kent (price 5s.), are an account of the investigations into Hop *Verticillium* Wilt, as related to soil conditions and nutrition, and a very useful review (with a bibliography) of the literature dealing with the nutrition of hops.

Lord Derby Gold Medal Trials, 1949 At a recent meeting of the Lord Derby Gold Medal Trials Committee, representing Lancashire potato growers and the National Institute of Agricultural Botany, the Lord Derby Award was made to the recently introduced potato variety, Craigs Royal.

The award was made as a result of comparative yield trials carried out in potato-growing districts in Cambridgeshire, Lincolnshire, Norfolk and Lancashire during the past four years. In these trials Craigs Royal showed such good yielding ability in comparison with the established varieties British Queen, Dunbar Rover, Ballydoon and Arran Banner, that the Committee had no hesitation in making the award.

Craigs Royal is one of the Craigs series of potato varieties raised by the Scottish Society for Research in Plant Breeding, and this is the second occasion on which the Lord Derby award has been made to one of the series.

Craigs Royal is of second early maturity and produces an oval tuber with white flesh and parti-coloured skin with pink markings confined to the eyes. The haulm is upright and of medium height. In making the award, the Committee was of the opinion that Craigs Royal represents a valuable contribution to the new field of coloured early varieties.

Craigs Royal is field-immune to the mild mosaic viruses X and A and is of hybrid origin, being the result of a cross between Craigs Defiance and Gladstone.

Rations for Farrowing Sows and Goats

Farrowing Sow Allowances. No limit will now be placed on the number of allowances that may be given for farrowing sows under the Extended Scheme of rationing. This concession brings the Extended Scheme into line with the Basic Scheme so far as farrowing sows are concerned. There is no alteration in the specified numbers of pigs in the various acreage groups for which monthly rations may be issued. Application for farrowing sow allowances must be made to the relative C.A.E.C.

Goats: Rations against Milk Sales. No deduction will be made during February, 1950, from the rations to goat-keepers allowed against milk sales. For the two months March and April the maximum deduction will be $\frac{1}{8}$ unit cereal, i.e., where the full cereal deduction of $\frac{1}{4}$ unit would normally be made, the deduction will only be $\frac{1}{8}$ unit, and where the normal deduction would be $\frac{1}{8}$ unit, no deduction will be made.

The Wybar

Poultry-keepers who are disappointed with the temporary decline of the White Wyandotte will be interested in the manufacture at Cambridge of the autosexing laced Wyandotte, either Gold or Silver.

The history of the new breed is described in detail by Mr. Michael Pease, amongst other articles in the Autosexing Breeds Association's Annual for 1950 (1s. from the Secretary, Autosexing Breeds' Association, 189 High Holborn, London, W.C.1.)

The difficulty in making the Wybar was to avoid recessive white plumage of the White Wyandotte, and the small eggs and infertility of other varieties. How it was overcome, by using Light Sussex, Brussbar, Red Wyandotte and Rhode Island Red, is related in the Annual, so that today Wybars exist, excelling in Wyandotte type and with egg production ranging from 100 to over 200.

Gavelkind

Kent has always been a county with a strong individuality. Indeed it has been argued that this area was originally settled not, like the rest of England, by the Angles and the Saxons but the Jutes, a people with somewhat different laws and customs; at any rate, the phrase "except, of course, in Kent" runs like a refrain through the standard history of Saxon England. It is not surprising, therefore, to find that in Kent there

survived until as recently as twenty-five years ago the ancient and interesting custom of gavelkind.* The custom was also to be found in some other parts of the country; but almost the whole of Kent was subject to it.

Strictly speaking, the word "gavelkind" covers a set of rules and conditions which governed a certain common type of land tenure. Some of these "incidents" of tenure, as they were called, were of relatively little significance, though one has a certain grim historical interest; for under gavelkind tenure a son of an executed man succeeded to his father's land without loss or difficulty, hence a cheerful Kentish proverb, "the father to the bough, the son to the plough". But by far the most important of these "incidents," and the one with which the word is always associated, ordained the descent of land not to the eldest son, as was formerly the normal case, but equally to all sons or, in default of sons and their issue, to daughters.

Coke, the great lawyer of the seventeenth century, derived the word from the phrase "give all kind," since the custom gave to all sons alike. Modern scholars, however, trace it, less picturesquely, from a Saxon word *gafol*, meaning "rent". At any rate, the origins of gavelkind tenure, though obscure, are certainly very ancient. Before the Norman Conquest, it seems, the equal partitioning of land among all sons was the general custom of the realm. After the Conquest and the establishment of the feudal system, primogeniture, or the right to the eldest son alone to succeed to land, superseded the more primitive custom, apparently to suit the supposed necessity of military tenure. But Kent continued in its old ways, which were so well known that land in Kent was assumed to be held under this type of tenure unless proof to the contrary was produced. Thus on occasion specified land was "disgavelled" by statute and so came under the Common Law rules of primogeniture.

The social and economic importance of this custom were considerable, for it checked the creation of large landed properties and thus acted as a protection for the smaller man. No doubt, therefore, it contributed to the freedom and independence which were so marked a feature of Kent in medieval and later times and to the development of the famous class of Kentish yeoman whose wealth inspired many a proverb. According to one Kentish saying for instance:

All blessed in health and as for wealth
By fortunes kind embraces,
A Yeoman gray shall oft outweigh
A knight in other places.

And in 1577, for instance, Lambard described the Kentish farmers as "neither so much bounden to the gentry by copyhold or customary tenure as the inhabitants of the Western counties be nor at all endangered by the feeble hold of tenant right as the common people of the Northern parts be . . . but in place of these the custom of gavelkind prevailing everywhere in manner everyone is a freeholder and hath in some part of his own to live upon. And in this estate they please themselves and joy exceedingly".

It is only in relatively recent years that this ancient custom has passed from law to history. For gavelkind was abolished by statute in 1925 and ceased to be "the common law of Kent" at midnight on the last day of that year.

Nigel Harvey.

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* Referred to in Mr. Ralph Arnold's recent book, *A Yeoman of Kent*, reviewed on p. 547 of this issue.

CROP PROTECTION PRODUCTS APPROVAL SCHEME

GROUP
NO
MINISTRY OF AGRICULTURE AND FISHERIES
DEPARTMENT OF AGRICULTURE FOR SCOTLAND
This product is guaranteed by
to conform to a standard approved by the Ministry and the Department
for preparations to be used for the purposes given on this container and
is included in the approved list under the
CROP PROTECTION PRODUCTS APPROVAL SCHEME

In 1942 the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland jointly put into operation a voluntary scheme by which official approval could be granted to proprietary insecticides and fungicides used for the protection of growing crops. Since that time, most of the important groups of insecticides and fungicides have been dealt with, and many approved products are now available on the market. Complete lists of approved products have been published periodically and have been issued, on application, for the guidance of growers in the selection of materials for use in the field.

It has now been decided that the scheme shall be extended to include herbicides. A start will be made with a limited number of selected groups and an announcement will be made later inviting applications from manufacturers for the official approval of proprietary products in these groups.

Following this extension, the scheme will be known as the Crop Protection Products Approval Scheme, and newly approved products will bear a modified design of the official approval mark, as illustrated. The new design of the mark will be incorporated in the labels of products already approved as these are reprinted.

From 1950, the full list of approved products will be published in January of each year. Growers and others interested will then know just when to expect a new list. The names of products added between successive issues of the full lists will be published as before in AGRICULTURE. A booklet giving the list for 1950 may be obtained free on application to the Ministry at St. Andrew's Place, Regent's Park, London, N.W.1.

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* Described in *Agriculture*, 1943, **50**, 331

BOOK REVIEWS

Wheat in Great Britain (Second Edition). J. PERCIVAL. Duckworth. 18s.

To those who have had the privilege of studying the unique series of wheats collected at Shinfield by Dr. John Percival, the revised edition of *Wheat in Great Britain* will be especially welcome. To others interested in wheat, whether farmers or students, seedsmen or millers, the clear and interesting presentation of the subject-matter makes this book extremely attractive.

Part I opens with an account of research into the early history of wheat-growing in Britain, beginning with the discovery of a primitive type of *Triticum vulgare* at Hembury Fort (Devon) which dates back, perhaps, to 2000 B.C. There are descriptions of later types resembling Emmer, taken from barrows of the Early Bronze Age, and a form closely resembling *Triticum Spelta* which was found in an Iron Age settlement at Meare (Somerset), dating from about 150 B.C. During the more or less settled times of the third and fourth centuries of the Roman occupation, agriculture was widely extended in the lowland half of the country, roughly east of a line from Durham to East Devon, but much of this land subsequently became derelict.

Succeeding chapters deal with bread, climate, cultivation, sowing, and yield, the present distribution of the crop, export and import, classification, and the improvement of wheats. Attention is drawn in this edition to the special interest of some recent introductions of spring-sown varieties which have a high milling and baking quality and are capable of giving high yields. The records of acreage and annual yield from 1771 to 1946 are most impressive when studied in relation to the increased use of fertilizers and to the special efforts made during the recent war.

The second part of the book gives detailed descriptions of the wheats now in cultivation in Britain, and with the inclusion of newer varieties such as Holdfast, Juliana, Warden, Bersée, Vilmorin 27, Steadfast, Atle, Fylgia, and Progress, the edition is brought into line with current practice and embraces the "Recommended List" of wheat varieties.

Full botanical descriptions of some eighty distinct varieties are given, with photographs of ears and grain of the newer forms. There are no drawings of the glumes to indicate the most readily distinguishable features, but there is a useful series of photographs of glumes of all the older varieties.

Dr. Percival's monograph *The Wheat Plant* is still the standard work of reference on wheat varieties throughout the world, and *Wheat in Great Britain* is recommended to all who wish to gain a broad knowledge of wheat-growing in Britain throughout the centuries and of the general botanical characteristics of varieties cultivated in this country during the past fifty years.

F.R.H.

A Yeoman of Kent. RALPH ARNOLD. Constable. 12s. 6d.

This book is described as "an account of Mr. Richard Hayes (1725-1790) and [illegible] the villiage of Cobham in which he lived and farmed". And that is exactly what it is. It is a very human portrait of a rather self-opinionated Kentish yeoman farmer, painted after 200 years by another resident of Cobham who holds the village and Kentish traditions in no less esteem than did Hayes.

The author, drawing on the diary of Richard Hayes, who lived at Owletts and farmed some 250 acres adjoining the estate of the Earl of Darnley at Cobham Park, has reconstructed the eighteenth century daily life of this gentleman farmer. He has also reproduced his sturdy independent views, as recorded in the diary, on things in general, including politics, life in the parish and neighbourhood, and the doings of his neighbours.

The book deals with a most interesting period of English history. It covers 200 pages and includes chapters headed—Cobham, Cobham in the eighteenth century, A Yeoman of Kent, The Hayes Family, Life at Owletts, Church and Parish Business, The Farms, Shooting and Cricket. Richard Hayes grew fruit and hops as well as the ordinary farm crops, and the book gives a good picture of the farming practices which were usual in the Gravesend-Rochester area during that period. The detailed costs of growing hops are particularly interesting. The effect of the Corn Laws, the system of land tenure, and particularly the form of Kentish land tenure known as Gavelkind*, are all well described.

The book is well written and attractively produced. It is illustrated with 28 excellent photographs. It is a fascinating book of absorbing interest to anybody who has a local knowledge of Cobham and its neighbourhood. It should appeal strongly to all Men of Kent and Kentish Men who take a pride and interest in the history of their county, and to all students of agricultural history.

G.H.G.

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* A note on Gavelkind appears on pp. 544-5.

Farm Mechanization Handbook. P. A. Reynolds. Temple Press. 8s. 6d.

This is not the sort of book that will stay neat and prim on the farmer's bookshelf; it will soon become defaced by black, oily finger-marks. It will probably come to rest at the back of the bench in the workshop, or even in the toolbox of the tractor, alongside the maker's manual and list of spare parts.

Nevertheless this book is much more than an instructional manual on the repair and maintenance of farm machinery; it is also a textbook giving very valuable information on engineering principles. A good example of this function of the book is the chapter on Tractor Hydraulic Systems, which clearly and briefly describes the fundamental principle of an hydraulic lifting arrangement, and then goes on to examine the actual practical lay-outs in use of four well-known makes of tractor. The ingenious "cut-away" diagrams used in this chapter are particularly helpful to an understanding of this part of the mechanism of modern tractors, a part which, if only because most of its apparatus is totally enclosed in the body of the tractor, has been a mystery to many operators.

The book also contains a batch of diagrams, full of detail but marvellously free from confusing overlaps, showing the design and construction of several well-known tractors. These diagrams, on double-size sheets, fold neatly into place, and anyone who possesses one of the tractors depicted here is likely to get much enjoyment and profit by tracing out the position of the various parts of his machine.

H.J.H.

Soilless Growth of Plants. (2nd edition Tom Eastwood). Carleton Ellis and M. W. Swaney. Reinhold Publishing Corp., New York (London, Chapman and Hall). 28s. 6d.

The time when soilless cultivation was a "new-fangled stunt," laughed at by some and fulminated against by others, is past. Many of our most progressive horticulturists are using these methods on a large or small scale, and one glasshouse nursery of 4 acres is now devoted solely to sand culture. In America soilless cultivation, especially for glasshouse flowers, is now firmly established as a routine procedure in many nurseries.

Early books on the subject reflected its immaturity, but since the war more than one book has treated it in an "adult" manner. The second edition of *Soilless Growth of Plants* illustrates this "growing-up" of the idea. In the first edition "nutrient solution culture" appeared to be something mainly for the amateur or the crank to play at; in the entirely revised version it is a book for the serious student of the subject. It is true that the small unit for the amateur is still described, even down to methods for single plants in bowls or jars, but the greater part deals with large-scale commercial application.

The author gives detailed instructions for the operation of all three of the basic methods—water culture or "hydroponics," sand culture, and the sub-irrigation system—but concludes that as a commercial proposition the last is the most promising. He lists as its chief advantages over water culture, better root aeration, easier control of the nutrient ion levels in the solution, and greater ease of setting and supporting the plants. In comparison with the less costly sand culture method, he claims as advantages for sub-irrigation less waste of water and nutrients, less labour in chemical and water applications, and greater control of the nutrient levels. No attempt is made in the book to give comparative figures for costs of production in soil and soilless culture, but he quotes growers as claiming up to 50 per cent reduction in overall costs. Incidentally, it may be of interest to note that in some recently published studies in the *Proceedings of the American Society for Horticultural Science*, operating costs for carnations grown in soil were 28 per cent higher than for those grown by sub-irrigation in gravel. This figure, however, does not include overhead costs and non-expendable items.

The book is the most complete and up-to-date manual of soilless cultivation yet published and should be studied by all those in any way interested in these methods. The difficult subjects of the composition, testing and control of the nutrient solution are explained clearly and not too technically for the non-scientifically trained, although the approach throughout is scientific and refreshingly free from bias and emotionalism.

The first fault which may be found with the book is one common to many American horticultural works—that no reference is made to work outside that country. Advances both in technique and control have been made in Britain, but these are completely ignored.

R.H.S.

BOOK REVIEWS

Farmers' Co-operation in Sweden. GULLANDER ÅKE. Crosby Lockwood. 7s. 6d.

Co-operation is the basis of farmers' organization in most countries, but it shows a wide variety of forms and of degrees of cohesion and success. Denmark used to be regarded as the classic example of scope and development, but during recent years France and Sweden have been recognized as leaders in the process of adapting co-operative forms of organization to the commercial and political requirements of the modern world.

Although the Federation of Farmers' Co-operatives in Sweden has always welcomed inquiries, there was need of a good general description of their movement in its agricultural and economic environment. Now Mr. Gullander, a farmer, traveller and internationalist, has provided an excellent general guide in conversational style, with over twenty illustrations, and enough statistics of numbers of societies, membership and trade to give firm views of quantities. But here also are prices paid for milk and rates of wages of farm workers, accompanied by a brief description of machinery for fixing prices and wages. The commodity organizations include those concerned with milk, meat, eggs, alcohol, furs, starch, flax, and hemp, and oil-seeds, while in addition there are other organizations for buying and selling and for credit. Most of these are linked in district unions and all are members of the Central Federation. More or less in general, as in the case of a slaughterhouse, "the Federation supplied an excellent scheme, the Farmers' Union the spirit of co-operation". The Federation maintains for co-operatives accounting and auditing, law and taxation, statistical and market research departments, with a school and educational and publicity departments. It also maintains an architectural department to advise on buildings for co-operatives and houses and buildings for farms. The Farmers' Union has raised its membership from 19,000 in 1930 to 188,000 in 1947.

Mr. Gullander ranges from the Swedish farm home and its mistress, not forgetting a farmers' co-operative laundry, to the International Federation of Agricultural Producers and international situations; but always simply, pleasantly and effectively.

A.W.A.

Agricultural Education in Great Britain. N. M. COMBER. Longmans Green. 1s. 6d.

In 28 pages of economical prose Professor Comber describes the parts played in the provision of "agricultural education" by the university and college, the farm institute, the local education authority, the research institute, the Young Farmers' Club, part-time further education classes and the secondary schools. He makes the important distinction between the use of agricultural teaching to prepare the professional and the contribution that agricultural interests can make to a realistic scheme of general education. There is a difference between vocationalism and realism. " . . . . . agriculture is so fundamental to human life and welfare that some instruction connected with it can readily be given to all people without any presupposition that they are going to be agriculturists . . . . "

It is, however, from the professional, the vocational, point of view that the author deals with the subject, and in doing so he makes clear how the present has developed from the past. Though there has been much gain there has been some loss, and the disappearance of the boarding grammar school that provided some of the facilities demanded today is to be regretted; a mention of it might have been made in this book.

More emphasis might also have been laid upon the scholarship system of the central and local governments, and of the significance of the chain whose links are school—Young Farmers' Club— day continuation course—institute (or college). The few attempts that have been made to make this chain effective in training recruits and to construct a bridge into farming for the boy and girl from other than farming families would have been worth mentioning, and the need for co-operation between the farming organisations, the local educational authority, the Ministry of Labour and the Young Farmers' Club might have been emphasized as a necessary part of agricultural education.

These criticisms may be met in a subsequent edition, when the opportunity might be taken to bring the section on Young Farmers' Clubs up-to-date. The work of these clubs does not necessarily include individual projects, and the members' interests are much wider than the author suggests— a fact of great importance when considering agricultural education as a whole. The dates and the description of the financial arrangements need some correction.

Professor Comber has, however, provided a very clear account of the growth of an elaborate and unique system; and the logical form that this account takes and the high quality of the writing are characteristic of his work. The 13 photographs are aptly chosen.

A.V.

BOOK REVIEWS

Deserts on the March. PAUL B. SEARS. Routledge and Kegan Paul. 10s. 6d.

First published in America in 1936, this book soon became a best seller—and rightly so. It tells the story of soil erosion, as far as 1935, simply and dramatically. The U.S. Soil Erosion Service (later, the Soil Conservation Service) was set up in that year, and the transformation it was to effect on the American scene was not predictable. With soil erosion spreading through the country like an infectious disease, and with practically nothing being done to check it, the outlook was black. And Dr. Sears has drawn it black, but with a note of prophetic hope that the American people will devise means of conserving their natural resources without abandoning their basic political and economic principles. It looks now as if his hope may be realized, but although nearly everything that he says is equally true today, the book gives the impression of being rather out of date.

Books are still being written in a similar vein, but the emphasis is increasingly on what has been and can be done to save the soil. *Deserts on the March* gives an authoritative picture of the fundamental ecological causes of soil deterioration and erosion. It had an important influence in making the public aware of the gravity and urgency of the soil-erosion problem which America now believes she is solving, but which still needs, in other countries, the force of an enlightened public opinion to spur authority to action. Dr. Sears does at any rate give a very vivid picture of the background against which the battle for the soil is being fought in the United States.

G.V.J.

The Efficient Use of Fertilizers. F.A.O. Agricultural Studies, No. 9, Washington, 1949, H.M. Stationery Office, 14s.

This publication of the Food and Agriculture Organization brings together for the first time, in brief form, world experience in the use of animal manures, fertilizers and other soil necessities such as lime, to increase crop production. It is a practical example of co-operation extending across national borders. Thirty-two specialists from fourteen countries took part in its preparation; fertilizer practices in thirty countries are referred to in the text.

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The final chapter suggests the type of question that a farmer must ask himself about his soil management practices, and describes the agricultural services that could help him in determining his crop needs, and in making the best use of manure and fertilizers; the extent to which such services are actually available in different countries is shown.

A bibliography of some 200 works on the various aspects of fertilizer use is included, together with numerous illustrations with explanatory captions.

D.H.

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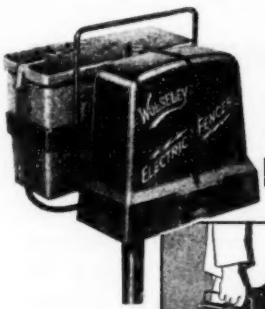

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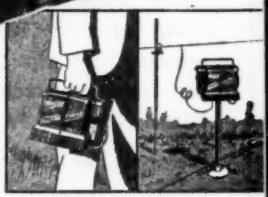

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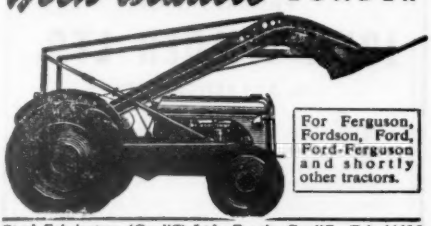

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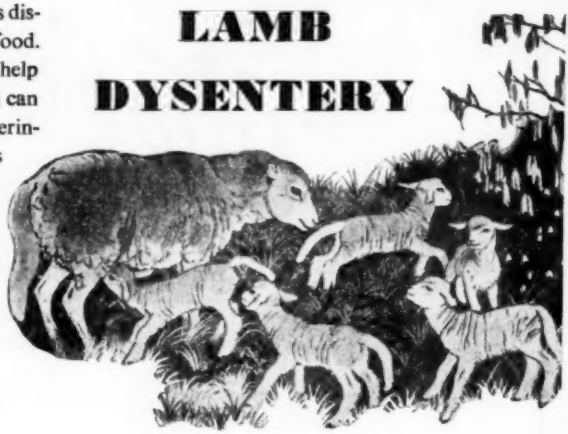

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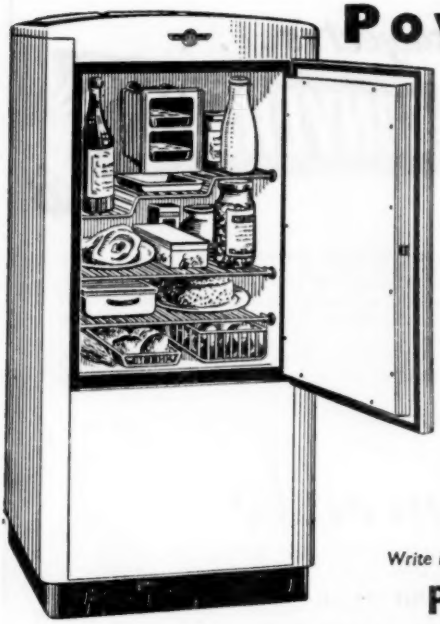

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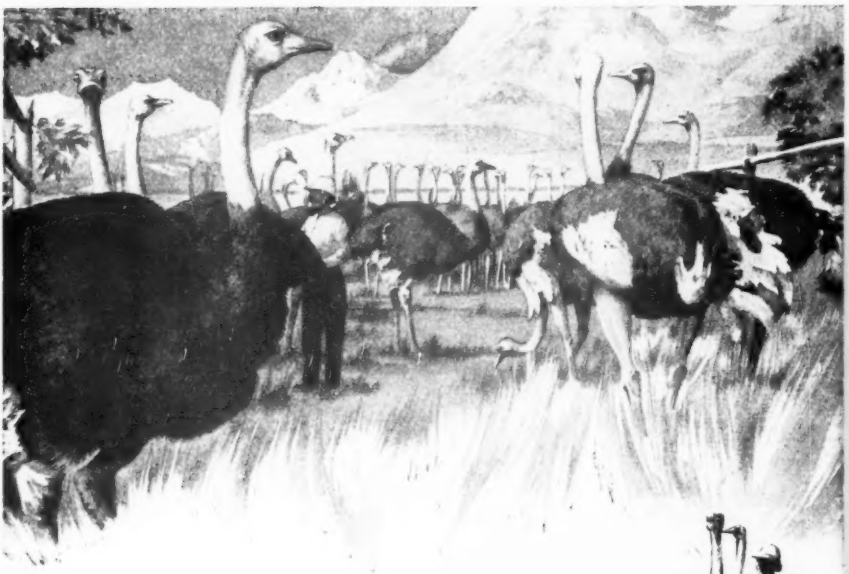

Ostrich farming is one of the major industries of Rhodesia, thanks to the consistent popularity of these feathers as a form of feminine adornment. Traditionally, an ostrich rather cares for the odd nail or diamond, as part of its diet, but no doubt it gets its proteins in its own way.

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What devaluation means to us

Every extra ton of food that can be produced in this country will represent an important contribution towards the solution of our present economic difficulties, and will help to establish a balance between our dollar income and our dollar purchases.

Are *you* using adequate dressings of COMPLETE FERTILIZERS for all your arable crops?
You are probably not getting maximum production unless you are using for

POTATOES — not less than 10 cwt. per acre
CEREALS — not less than 3 cwt. per acre
SUGAR BEET — not less than 8 cwt. per acre
OTHER ROOTS — not less than 6 cwt. per acre
FORAGE CROPS—not less than 5 cwt. per acre

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